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REPORT OF THE ORE DEPOSITS (OTHER
THAN THOSE OF TIN) OF NORTH
DUNDAS.

[Four Plans.]

Zeehan, 30th April, 1902.

SIR,

I HAVE the honour to forward the following Report on the Ore Deposits of North Dundas. These deposits are extremely varied in their nature and metallic contents, and include a number of types which are found elsewhere on the West Coast.

The following is a list of the principal types which I have noted in the district:—

1. Tourmaline cassiterite veins (Penzance type).
2. Pyritic cassiterite deposits (Commonwealth type).
3. Axinite and pyritic copper deposits (Colebrook type).
4. Tourmaline gold copper veins (Mt. Black type).
5. Pyritic zinc-lead and copper deposits (Mt. Read type).
6. Fahlore and galena veins.
7. Deposits of nickeliferous pyrrhotite.

Of these types, the first two have already been described in my report, recently published, "On the Tin Ore Deposits of North Dundas"; the remaining types will be dealt with in the present Report. I regret to say that, with regard to some of them, the information which I have been able to collect is somewhat meagre. Many of the mines have been abandoned for years, and it is very difficult, now, to obtain reliable information concerning them.

AXINITIC AND PYRITIC COPPER DEPOSITS
(COLEBROOK TYPE).

The Colebrook Prospecting Association. No Liability.

This company holds Sections 236-93M, 239-93M, 216-93M, and 5364-93M, with a total area of 286 acres. The mine is reached by a pack-track from Ringville, from which it is distant nearly three miles in a direction a little east of north. The natural outlet for the mine is to the Emu Bay Line, by

a self-acting tramway, a route for which has already been surveyed. The country rock consists of hard fine-grained laminated shales and slates, with beds of impure limestone or calcareous shale. To the west of the mine there is a belt or massive dyke of gabbro, peridotite, and serpentine, which runs in a northerly direction from a little north of the Fahl-ore Mine. This belt goes up to nearly 20 chains in thickness.

Plate I. gives a topographical sketch plan of the mine workings, together with the supposed positions of the principal ore-bodies. These are four in number, and are situated on either side of a steep spur, which runs in a north-easterly direction. They are roughly parallel to one another, striking for the most part a little east of north, and dipping to the west at high angles. The deposits vary in width from 10 up to over 60 feet, and have been traced for distances varying from 550 to 700 feet along their strike.

The minerals forming the great mass of the ore bodies are as follows:—

<i>Non-metallic.</i>	<i>Metallic.</i>	
Axinite	Pyrrhotite	
Actinolite	Pyrite	
Datolite	Marcasite	
Danburite	Chalcopyrite	
Calcite	Arsenopyrite	
Quartz	Galena,	} traces only.
	Zinc blende,	
	Tetrahedrite,	

The most striking feature in these deposits is the great abundance of the mineral axinite, a boro silicate of aluminium and calcium. This mineral occurs abundantly in all the ore-bodies. The structure is often banded, but in other parts it is quite massive; sometimes it occurs in irregular patches or masses in the adjoining country. Where it occurs in the ore-bodies it is usually associated with considerable quantities of pyrrhotite and chalcopyrite.

Actinolite (silicate of calcium, magnesium, and iron), is also very abundant, both in the ore-bodies themselves and in the adjoining country. The structure is generally banded, much of the ore consisting largely of alternate bands of axinite and actinolite. It is worthy of note that the impure limestone, which may generally be found associated with the deposits, nearly always contains minute crystals of actinolite distributed through it. The latter gradually increases in quantity, till we have, finally, a rock composed almost entirely of actinolite.

Datolite and danburite (silicates of boron and calcium), occur associated with calcite and axinite as the lining of cavities in the ore-bodies. Neither of these minerals is very abundant.

Quartz is nowhere abundant, and is practically absent from the greater part of the ore.

Of the metallic minerals present, pyrrhotite is the most abundant. This occurs in large bands and masses up to 10 or 15 feet in thickness. It is associated with copper pyrites, and crystals of axinite may often be found embedded in it.

Pyrite and marcasite are present in relatively small quantities.

Chalcopyrite is widely distributed. It occurs in small grains throughout the large masses of axinite, and is also present in the massive pyrrhotite. This is probably the only copper-bearing mineral present in the ore-bodies.

Arsenopyrite occurs distributed in small quantities through the ore-bodies. In places it occurs massive, in the form of veins up to 6 or 8 inches in thickness, and may become a by-product as soon as mining operations are commenced. It is, however, nowhere present in very large quantities.

Galena, zinc-blende, and fahlore are only present in very small quantities. Where they do occur, they are very low in the precious metals.

Bismuth has been detected in traces in one or two special samples, but it is absent from the greater part of the ore.

The content of the ore in gold and silver is, unfortunately, low. Most of the assays return only a trace of gold, and from one-half to an ounce of silver to the ton.

It is a remarkable fact that the ore-bodies have suffered very little oxidation. It is true that several bodies of gossan are known, but these are insignificant in comparison with the amount of ore that is unoxidised. As a rule, the ore is quite undecomposed within a few feet of the surface. The gossan is very low in both gold and silver.

The several deposits are separated by bands of hard shale or slate, which is also often highly mineralised, and, as a rule, the walls of the deposits are not well defined. Often there are branches and tongues of axinite and actinolite running out into the wall-rock, and in places these constitute masses of considerable size.

As regards the origin of the Colebrook deposits, the banded nature of the ore at once suggests metasomatic replacement

of the impure laminated limestones, which occur in the vicinity of the ore-bodies. These limestones often contain small crystals or fibres of actinolite, and when the latter increases in abundance a complete passing over is to be observed from the impure limestone to actinolite rock. The latter contains seams and bunches of axinite and the other constituents of the ore-bodies, in all proportions. As further evidence, it may be remarked that the minerals forming the bulk of the ore-bodies (axinite, actinolite, calcite) all contain considerable quantities of lime. I think, therefore, we are fully justified in assuming that the Colebrook ore-bodies have been formed by the replacement of beds of impure limestone; and the question arises, whence came the solutions which brought about such a profound alteration? There can be no doubt as to the answer to this question. The mineralogical composition of the Colebrook ore-bodies is essentially the same as that of the axinite veins which are associated with the pyritic tin ore deposits in the vicinity of Commonwealth Hill. In my previous report I have shown that the filling of these veins is the result of hot ascending solutions containing boron compounds emanating from the granite magma during the process of consolidation. There can be no doubt that the Colebrook ore-bodies have been deposited by similar solutions.

It is not evident, at present, what channels have been used by the ascending solutions. There are many fissures cutting across the deposits, and it is possible that these may have been utilised, but I think it more probable that the main channels were along the planes of sedimentation. Although I am quite satisfied that the above is a satisfactory explanation of the origin of the deposits, it is quite possible that they do not in every case form continuous bodies as shown on the plan. They have been proved to be to a great extent continuous, but in one or two places, as for example, in No. 2 ore-body, south of "D" open cut, the ore-body appears to have pinched, for it is not met with in "E" cut. Probably it will be found to the east of this cut, as shown on the plan, as the walls in "D" open cut strike in this direction, but if not, this will not be evidence against the replacement theory. Often replacement deposits occur as lenticular masses along certain lines of favourable country, and it is quite possible that some of the exposures at the Colebrook Mine may be of this nature. It may also be that some of the exposures which are supposed to be along the same formation are really separate. Thus, the exposure in "H" tunnel may not be a continuation of No. 1 lode, but a separate

deposit. These points cannot be cleared up until the ore-bodies have been driven on underground, or trenched along on the surface.

With regard to the copper contents of the ore-bodies, I regret that I have been unable to obtain much definite information. Some years ago, when a wealthy syndicate held an option over the property, the mine was exhaustively sampled, but, unfortunately, no record appears to have been kept of the details of these assays. It was thought at that time that the whole spur on which the ore-bodies occur constituted one immense ore-body, striking in a north-easterly direction, and the proposition was then to mine away the whole hill on the open-cut system. This proposal has long since been abandoned. All that is now proposed is to mine the richer portions of the ore-bodies by the ordinary methods of mining, leaving the lower grade ore and the barren country standing. The only records of the sampling of the mine which appear to have been preserved are averages of great numbers of bulk samples taken as the work was proceeding. These averages are supposed to represent the contents of the whole ground opened up, and it is expressly stated that the barren country is included in the averages, as well as the copper-bearing ore. As the details of these assays have not been recorded, the only thing to be done now is to re-sample the mine. The method of doing this will be referred to in another part of this Report.

The assay returns given below are those furnished to me by Mr. T. Williams, the mine manager, at the time of my visit. As most of these were taken before his time, he could not give me any information as to the method of sampling adopted; but, in the case of the samples taken by Mr. T. Williams himself, he tells me that they were from chips broken here and there from the ore exposed. This is a rough-and-ready method, and could hardly be depended on to give reliable results.

THE MINE WORKINGS.

Almost the whole mining work has been laid out under the impression that the whole ridge constituted one immense ore-body, striking about north-east and south-west. For this reason, most of the tunnels were put in in a north-easterly or south-westerly direction, so that they are really crosscuts cutting diagonally across the ore-bodies. Practically, no driving on the course of the ore-bodies has been done. This is to be regretted, as, although there is no

reason to doubt that the ore is fairly continuous along the course of the ore-bodies, it would have been more satisfactory if this had been proved by actual mining.

No. 1 Ore-Body.—Exposed in No. 2 adit, B bench, two trenches, and in H tunnel. (See Plate I.) In No. 2 adit, the lode has been cut across at an angle of about 45° , the hanging-wall being cut in the end of the tunnel. The walls of the tunnel are much stained with copper sulphate, and copper pyrites may generally be seen by chipping the stone. Some places are evidently richer in copper than others, and it would be well to sample the tunnel in sections, in order to ascertain the value of the richer bands.

B bench is about 35 feet above No. 2 adit. The lode is very wide here, and there is about 20 feet of ore which looks promising. Mr. T. Williams took a sample from the richer portion of the ore-body exposed at this point, by chipping pieces here and there over the face of the bench. This gave a return of 5.9 per cent. copper and 1 oz. 15 dwts. of silver per ton.

In the two trenches there is not much to be seen at present, as they are old and partly filled in. A bulk sample taken by Mr. R. Williams from the most northerly of these trenches gave a return of 1.36 per cent. copper, and 9 dwts. silver, per ton.

H tunnel has penetrated what is believed to be No. 1 ore-body for a distance of about 20 feet, without reaching the other wall. An average of three bulk samples taken by Mr. T. Williams gave 1.67 per cent. of copper and 17 dwts. of silver per ton.

No. 2 Ore-Body.—Exposed in C tunnel, D open cut, 150-foot level east, No. 1 tunnel and D trench. In C tunnel and D open cut, the lode looks promising, and probably this is the richest ore-body exposed in the mine at present. The ore-body is considerably wider in the tunnel than it is on the surface. Average of 49 bulk samples from D open cut and C tunnel taken by Mr. R. Williams gave 2.9 per cent. copper and 1 oz. 1 dwt. of silver per ton; this assay is from the whole of the stone exposed in the tunnel and in the open cut, and includes much that is practically barren, so that it is not a fair sample of the ore that would be won if mining operations were being carried on. These workings should be again thoroughly re-sampled in small sections, in order to find out the quantity and value of the ore which is available. There is no other way to get at a reliable estimate.

The 150-foot level east was put across the lode 350 feet south of D open cut. The tunnel passed diagonally through the ore-body for a distance of 45 feet, and was continued in practically barren country for a further 90 feet. An average of 23 bulk samples, taken while the tunnel was being driven, gave a return of 1.6 per cent. copper and 9 dwts. 5 grs. silver per ton. As only one-third of this was really in ore, it is evident that the average for the ore-body should be considerably higher than this. This should also be re-sampled carefully.

In No. 1 tunnel the lode was cut 40 feet from the entrance; a drive was then put in along the eastern wall of the lode in low-grade gossan, and, in the end of the drive, a short crosscut has been put in west, without reaching the other wall.

D trench has lately been put in, and has exposed a copper-bearing formation about 20 feet in thickness. A bulk sample taken by Mr. T. Williams gave a return of 3.06 per cent. of copper and 16 dwts. of silver per ton. To the south-east of D trench, there is another cutting, in which an axinite formation of considerable width is exposed; this contains some pyrrhotite and copper pyrites, and may be regarded as part of the ore-body, but it is pretty certain that the western portion is the only part that carries appreciable amounts of copper.

No. 3 Ore-Body.—Exposed in the summit-trench, in the crosscut from the main shaft, in M tunnel, M trench, and in N tunnel.

In the summit-trench, the ore-body is about 20 feet wide, with 10 feet of highly-mineralised country on either side. Average of six bulk samples taken from this trench, for a width of 40 feet, gave 2.16 per cent. copper and 1 oz. silver per ton.

The lode is again cut in a crosscut from the main shaft 130 feet further south. I was not able to examine it at this point. A trench put across the formation at the surface shows that the lode at this point is highly decomposed.

About 500 feet south of the summit-trench, M tunnel has been put in, and cut across the lode for about 20 feet without reaching the footwall. The lode consists mostly of axinite, actinolite, and copper pyrites. An average of 3 bulk samples taken by Mr. T. Williams from this tunnel and the trench above gave 3.4 per cent. of copper and 18 dwts. silver per ton.

The same lode has been cut 180 feet further south by N tunnel. It is here about 10 feet wide, but it is completely decomposed.

No. 4 Ore-Body.—Exposed in B trench, Open cut western fall, and in A tunnel.

In B trench, the lode is 45 feet wide. A cut was being put into the ore-body at this point at the time of my visit, and some nice-looking ore was exposed.

In the Open cut western fall, a large amount of stone has been broken down. It consists for the most part of axinite, with a little copper pyrites through it. There are also bands of very dense pyrrhotite exposed, and some fair-grade copper ore. An average of 16 bulk samples taken from B trench and this open cut gave a return of 3.12 per cent. copper and 1 oz. 3 dwts. 16 grs. of silver per ton.

There are two other bodies known on the property—one to the east (the east lode), and one to the west (the west lode), of the above workings. Both of these ore-bodies are of the same character as those already described, but they have not yet been thoroughly opened up.

In addition to the above workings, 5 bore-holes have been put in with the diamond-drill. The following notes on the results of these operations are taken from the mine manager's report:—

No. 1 BORE.—From No. 1 tunnel, south drive, bearing due south, total length 192 feet—

- 0'- 60'—Axinite, actinolite, magnetic pyrites, with little copper pyrites through it.
- 60'- 65'—Showed copper pyrites freely, best copper in bore.
- 65'- 94'—Axinite, actinolite, calcite, and little copper pyrites.
- 94'-142'—Impure limestone, with bands of axinite and actinolite alternating, and little copper pyrites in it.
- 142'-150'—Marked improvement, axinite, actinolite, and calcite, showing magnetic and copper pyrites freely.
- 150'-192'—Altered slates, with veins of axinite and magnetic pyrites, with little copper pyrites in these veins.

No. 2 BORE.—No. 1 tunnel west crosscut, bearing S. 30° W., total length 165 feet—

- 0'- 65'—Through magnetic pyrites, axinite, and actinolite, with a little copper pyrites through it.
- 65'- 98'—Axinite and actinolite, with a little copper pyrites, bands of altered slate alternating.
- 98'-165'—Soft gossanous formation.

No. 3 BORE.—From No. 2 adit, bearing S. 44° W., 183 feet 9 inches in length—

0'-50'—Principally magnetic pyrites and axinite, with copper pyrites through it.

50'-130'—Intrusion of country.

130'-183'—Magnetic pyrites, axinite, and actinolite, with copper pyrites in it through the whole distance.

No. 4 BORE.—From D open cut, bearing about west, total length 90 feet—

0'-66'—Through magnetic pyrites and axinite, showing copper pyrites all through it freely.

66'-72½'—Intrusion of country.

72½'-77½'—Quartz and arsenical pyrites, with little copper pyrites through it.

77½'-90'—Clean country.

No. 5 BORE.—Vertical bore from D open cut; total depth 298 feet—

0'-186'—Magnetic pyrites and axinite, with copper pyrites all through it.

186'-298'—Axinite and actinolite; no copper.

I understand that one piece of core from each six feet was taken to be assayed, but I have not been furnished with the results. This method of sampling a core might lead to very misleading results, and I think it would be advisable to have the cores (which have been carefully preserved) properly re-sampled and assayed. In sampling the core, it will be necessary to break it up and quarter it down properly. It would be advisable to make a separate assay for each 6 feet, but, of course, where no copper is showing, an assay is unnecessary.

I think it will be evident from the above notes that a thorough sampling of the mine is most desirable. The method to be adopted should be very carefully considered, as the mine is a very difficult one to sample. The copper is not evenly distributed through the stone, but occurs in blebs and patches here and there. There are rich bands and poor bands, and, as the object of the sampling should be to determine the proportion of payable ore in the ore-bodies, these bands must be sampled separately. Sometimes the richer ore appears to occur in irregular masses, and in these cases there does not appear to be any method of ascertaining the proportion of rich ore other than mining on a large scale. However, I feel sure that a careful sampling of the mine will give pretty definite information as to the value of

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the ore-bodies. This should be carried out in the following manner:—In all the principal openings the ore-bodies should be carefully inspected, and the distribution of the copper pyrites determined as closely as possible. The copper-bearing belts should then be divided up into sections of not more than 6 feet in width, and the stone gadded off the sides of the tunnels or the faces of the open cuts. It would not be necessary to take off the whole surface exposed; if pieces were taken at equal distances, say 12 inches apart, all over the face, this would be sufficient. The stone broken from each section should then be quartered down, and assayed separately. If this were done, it would be known with a fair amount of certainty what proportion of the ore-body it would pay to mine. The richer portions could then be driven on, and their continuity proved.

The possibility of richer ore being found in depth is a subject upon which miners always speculate. In the case of the Colebrook Mine, I think it may be possible that some of the copper has become concentrated at lower levels, but I do not think that this can have taken place to any great extent. In almost all cases where rich concentrations of copper have taken place at and below water-level a large amount of gossan is present in the upper portions of the lodes, and it is the copper which has been leached out of this gossan-zone, and from portions of the lode which have been removed by denudation, that has been concentrated in the lower levels. Now, in the Colebrook Mine there is not a great deal of gossan in the upper levels, most of the ore-bodies being singularly undecomposed within a few feet of the surface. In other words, there has been very little leaching of the copper from the upper portions of the ore-bodies, and, therefore, there is not likely to be a great concentration of copper in the lower portions. Practically, I think that the mine should stand or fall on the work already done. If payable ore is not exposed now it probably never will be, and a careful sampling of the mine should determine the point once for all.

The ore of the Colebrook Mine is of an exceptionally favourable nature for smelting, since its mineralogical composition renders it practically self-fluxing. For this reason the cost of smelting should be materially less than at Mt. Lyell. On the other hand, the cost of mining would be more, as the open cut system could not be utilised. It would not, however, be excessive, as mine timber, for a long time to come, could be cheaply got from the hill to the south

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of the mine. On the banks of the Pieman River, a short distance from the mine, an excellent site might be chosen for a smelting works.

TOURMALINE GOLD-COPPER DEPOSITS
(MOUNT BLACK TYPE).

These deposits occur in what is commonly known as the "schist belt." The rocks consist principally of light-coloured argillaceous schists, with bands of dark slate, and, occasionally, quartzites and silicious schists; bands of a felsitic rock, which Messrs. Twelvetrees and Petterd have determined as keratophyre (a soda syenite porphyry), are common. South and east of the Mount Black Mine there is a very extensive belt of this rock, and a great number of small veins of the Mount Black type have been found in this belt. The keratophyre has often assumed a schistose structure, and when this is the case it is often extremely difficult to distinguish it from some of the schists. I have not been able to determine definitely whether the keratophyre actually cuts across the planes of stratification of the schists. The contact is usually very obscure, and it is remarkably difficult to determine where the keratophyre ends and the schist begins. I think that, as a general rule, the bands of keratophyre are parallel with the plains of stratification. In Messrs. Twelvetrees and Petterd's paper they express the opinion that the keratophyres are probably of effusive origin, and, therefore, of the same age as the schists. They have lately told me, however, that they are now of opinion that the rock is intrusive, and I may say that my own observations incline me to the same conclusion.

The tourmaline gold-copper deposits of the Mt. Black type are, for the most part, fissure-veins, either entirely in the keratophyre, or at its contact with the schists. They are usually small veins, with two well-defined walls, and often presenting a perfectly symmetrical banded structure. They are composed principally of quartz, tourmaline, fluorite (sometimes very abundant), iron pyrites, chalcopyrite, with a little arsenopyrite, bismuthinite, and wolframite. A large number of the veins are almost entirely composed of quartz, tourmaline, and a little pyrites. The lode of the Mt. Black Mine is the largest and most important of these veins, and, I fear, the only one which is likely to become of much economic value. Besides these true fissure-veins, there are two other replacement deposits (at the Salisbury and Chamberlain mines) in the schist-country, composed of quartz, pyrites,

and a little tourmaline, which I take to be connected with the same phase in the process of ore-deposition as that to which the veins of the Mt. Black type owe their origin. The presence in these deposits, of minerals containing boron and fluorine (tourmaline and fluorite), and also the presence of wolframite and bismuthinite, which are such common accompaniments of tin-veins, show that these deposits are, like the tin-ore deposits in the vicinity of Commonwealth Hill, and the copper deposits at the Colebrook, connected with the eruption of the granite. It seems probable that the process of ore-deposition has passed through a number of phases, deposits of different types being found at different periods and at varying distances from the seat of eruption. In this way, I think, we may find a satisfactory explanation of the fact that several different types of deposits are all connected with one and the same eruption.

The Mt. Black Proprietary Mining Company, No Liability.

Sections 58-93M, 59-93M, 4693-93M, total area 65 acres. This mine is situated in moderately-flat country, at the foot of Mt. Black, about half a mile to the east of the Rosebery township. The ore-deposit is a true fissure-vein, consisting of quartz, tourmaline, fluorspar, iron and copper pyrites, and, in parts, a good deal of wolframite and bismuth sulphide. The structure is banded, but not symmetrical, the bands of fluorspar, with bunches of bismuth sulphide, being found principally near the hanging-wall, and the quartz on the foot-wall. The tourmaline does not occur in bands, but forms little veinlets and bunches through the other minerals. The quartz contains a large quantity of tourmaline, in the form of fine needles. The lode is exposed at the surface in a stripped paddock, and at the mouth of an inclined shaft which has been put down on the lode. Here the lode strikes 60° W. of N., and dips to the east at an angle of 55°. The lode is 5 feet 2 inches thick at this point, measured perpendicularly to the walls. The hanging-wall is composed of keratophyre, and the foot-wall of a light-coloured fissile argillaceous schist.

About 200 feet to the east of the inclined shaft, a main vertical shaft was sunk to a depth of 100 feet, and at this depth a crosscut was driven to cut the lode. As all the workings were under water, I was unable to examine them, but Mr. C. M. Henrie, the metallurgist to the Tasmanian Copper Company, has kindly furnished me with the following notes:—The crosscut from the main shaft cut through

three separate formations before striking the main lode. No. 1 lode was 4 feet wide, consisting of bands of quartz-tourmaline, with a little fluorspar, iron pyrites, and a little copper. At 37 feet from the shaft, a silicious rock was cut, carrying a considerable amount of iron pyrites, and some copper pyrites scattered through it. At 61 feet from the shaft, No. 2 lode was cut; this was 15 to 18 inches in thickness, and of the same general character as No. 1. At 100 feet from the shaft, No. 3 lode was cut; this was small, and principally composed of iron pyrites. At 140 feet, the main lode was cut; this was 8 feet wide, with 6 feet of fair-looking ore. The main lode appears to have been cut at its richest and widest part, for, in driving north and south on the lode, it pinched very considerably, and the metallic contents also fell away. This corresponds also with what was found at the surface, so that it appears that it is a comparatively short shoot, or chimney, of ore, pitching at a high angle, perhaps vertically. By driving on the lode, other parallel shoots may be met with, but, if these are continuous, they should live up to the surface, and might be found by surface-trenching. I am also indebted to Mr. Henrie for the analyses of ore from the Mt. Black Mine contained in Tables I. and II.

TABLE I.—MOUNT BLACK MINE.

	I.	II.	III.	IV.
Gold, ozs. per ton.....	0.44	0.95	0.75	0.15
Silver, ozs. per ton.....	0.34	0.48	0.62	0.31
Copper, %.....	1.40	0.82	1.26	1.52
Bismuth, %.....	trace	7.44	—	trace
Lead, %.....	trace	trace	—	trace
Zinc, %.....	trace	0.31	—	trace
Iron, %.....	16.83	9.45	18.90	16.83
Silica, %.....	21.30	32.85	20.10	46.90
Alumina, %.....	5.39	12.02	11.90	12.96
Manganous oxide, %.....	0.14	0.12	—	0.15
Calcium, %.....	18.20	15.39	14.73	—
Calcium oxide, %.....	—	—	—	3.32
Magnesia, %.....	0.94	0.40	—	0.95
Fluorine, %.....	17.30	14.75	13.94	trace
Sulphur, %.....	13.24	0.90	18.00	6.64
Oxygen, in CaO.....	0.66	—	—	—
Oxygen, in FeO.....	1.67	0.94	0.90	3.49

i. Sample from face of south drive, main lode, about 12 feet from main crosscut.

ii. Sample from south drive, main lode, near hanging-wall.

iii. Bulk sample from small shipment taken by Mr. T. Dunn, mine manager.

iv. Bulk sample from No. 1 lode, 100-foot level.

TABLE II.—MOUNT BLACK MINE.

	I.	II.	III.	IV.	V.	VI.	VII.
Gold, ozs. per ton.....	0·85	0·26	0·70	0·84	0·30	0·09	0·42
Silver, ozs. per ton	1·15	0·74	0·80	0·66	0·60	0·48	0·58
Copper, %.....	0·61	0·10	1·15	0·48	trace	trace	0·52

- i. Iron pyrites, fluorite and quartz.
- ii. Fluorite, with iron pyrites.
- iii. Iron pyrites, fluorite, and quartz.
- iv. Iron pyrites and fluorite.
- v. Quartz.
- vi. Quartz.
- vii. Iron pyrites, fluorite, and quartz.

The above samples (Table II.) were taken from the main lode at the point intersected by the main crosscut.

From these analyses, it will be seen that the main value of the ore is in the gold contents, which carry between 5 dwts. and 1 oz. to the ton. In order to bring the ore into a marketable condition, an attempt was made to treat it by mechanical concentration, by which process it was hoped that a marketable product, containing the gold, silver, and copper values, would be obtained. A small mill was erected, consisting of a Blake crusher, one pair of rolls, two trommels, one two-compartment topping-jig, two four-compartment and one five-compartment jig, one spitzkasten, two frue vanners, and a Wilfley table. The mill only ran for one month. The loss in gold was excessive, and the ore in bulk did not prove as rich as had been expected. A few tons of concentrates were obtained, which carry a little over an ounce of gold to the ton, and between 2 and 3 per cent. of copper. The tailings carry over 5 dwts. of gold and $\frac{1}{4}$ per cent. of copper. I am of opinion that these results might be improved upon by more efficient ore-saving appliances. Very little classification of the slimes was attempted, and there was no provision made for the re-crushing of the finer middle products. I am not aware whether there is any free gold present; if there is, it could be won from the tailings by the cyanide process. There is nothing in the ore which should prevent its successful treatment, and the whole question really rests upon the value of the ore in bulk and the amount of stone available.

In the event of local smelters being erected in the district, it will probably pay the company to have its ore smelted direct, without concentration. The fluorspar in the ore

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would be very valuable as a flux, and would enable the smelting company to offer a favourable tariff. On the other hand, the bismuth contents are a disadvantage, but this appears to occur mostly in bunches, and, with a little care, almost all of it could be eliminated. With the exception of picked samples of bismuth ore, nearly all the samples which have been analysed have yielded only a trace of bismuth.

The Great South Rosebery.

Section 1065-93M, 79 acres. This section is situated to the east of the Mt. Black Mine. The country rock is, I believe, all keratophyre, though, where the structure is schistose, and the rock somewhat decomposed, this is difficult to determine with certainty. Quite a number of small veins of the Mt. Black type have been found on the section. They consist principally of quartz and tourmaline, with a good deal of iron and a little copper pyrites. Fluorspar is sometimes present in small quantities, but usually it appears to be absent. About the centre of the section one of these veins has been trenched along for about a chain, and its outcrop is exposed on the surface about two chains further north. This vein strikes 15° W. of N., and dips vertically. It is about 5 or 6 inches in thickness. In the north-eastern portion of the section a short tunnel has been driven to intersect a formation which is exposed on the brow of a small ridge. The formation consists of broken country, somewhat iron-stained, with stringers of quartz tourmaline. In the tunnel, a small leader of quartz tourmaline was cut, and further, in a belt of broken country beyond this, there is a little pyrites showing in the joints of the country, with bunches of quartz. A little to the south-west of the centre of the section, another vein has been driven on carrying quartz, tourmaline, fluorspar, and pyrites. This is said to have been a foot in width in one place, but in the face of the drive it is only 3 inches thick. South of this, on the flat, there is what is supposed to be the outcrop of a big lode, but I fear it is only iron-stained keratophyre, with a few stringers of quartz tourmaline through it. Near the western boundary of the section there is another lode, which has been intersected by a tunnel driven east. This has cut a formation about 5 feet wide, composed principally of broken country. On the eastern wall, there is a vein of decomposed matter, containing a good deal of copper pyrites, and is said to yield 14 per cent. of copper.

I regret to say that I do not think there is much hope of finding anything payable on this section, or on others which are wholly in the keratophyre belt. The keratophyre itself appears to be unfavourable to the process of replacement—to the operation of which, I believe, we owe the great majority of our larger deposits of copper ores on the West Coast. The veins met with in this section are simply fillings of open fissures, and their dimensions are, therefore, dependent upon the size of the original cavities. The contents of the veins are, unfortunately, very poor in the valuable metals, and there is no reason to expect them to become materially richer as depth is gained.

The above remarks apply also to a number of sections which lie to the south of the Great South Rosebery, along the valley of the Stitt River. A great number of small veins of a similar nature to those found on the Great South Rosebery have been discovered in this belt of country, and, although occasionally good assays may be obtained from them, I am of opinion that they are too small, and the country is too hard to permit of their being profitably worked.

The Salisbury Mine.

Section 4429-93M, 79 acres. This section is situated to the east of the Rosebery Railway Station, on the western slope of the Bald Hill, a spur running north from Mt. Read. The country consists of light-coloured argillaceous schists. Just below the road which connects Williamsford with Rosebery, a tunnel has been put into the hill in an easterly direction, and has intersected a small vein, containing a good deal of galena and some zinc blende and copper pyrites, associated with fluorspar and a little tourmaline, carbonate of iron, and quartz. The vein is 6 or 8 inches in thickness, strikes 15° east of north, and dips nearly vertically. About 200 feet higher up the hill, another tunnel has been driven, and in this a strong quartz formation has been cut through and driven on for some distance north and south. In the south end, the lode is 4 feet 9 inches wide, and in the north end 2 feet 9 inches. The lode-matter consists principally of dark-coloured quartz, with a good deal of iron pyrites through it. I did not notice any fluorite in the stone, but I found some minute black needles, which I took to be tourmaline. The stone carries a few dwts. of gold, and should become of value as a silicious flux when smelting operations

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are started in the district. The following is the result of an analysis of the stone made by Mr. C. M. Henrie:—

- Gold, 4 dwts. per ton.
- Silver, 1 oz. 2 dwts. per ton.
- Copper, 0.93 per cent.
- Iron, 9.53 per cent.
- Silica, 69.83 per cent.
- Sulphur, 5.69 per cent.
- Manganous oxide, 0.21 per cent.
- Alumina, 12.42 per cent.
- Oxygen with FeO, 1.1 per cent.
- Zinc, lead, lime, and magnesia, traces.

The lode is not a fissure vein, but is probably a replacement deposit parallel in strike and dip to the surrounding country. The section is now vacant.

The Chamberlain Mine.

Sections 1908-93M and 911-93M. These sections are situated to the south-west of the Salisbury Mine, on Section 911. A lode of exactly the same character as the silicious lode on the Salisbury Mine has been cut through in a trench on the surface. It is 10 feet 6 inches wide, striking about north and south, and dipping to the east at an angle of 50°. Another small lode has been cut further west, consisting principally of copper and iron pyrites associated with quartz, from which assays up to 14 dwts. of gold per ton have been obtained. Neither of these lodes are workable under present conditions, but if smelting works are erected in the district, they will no doubt receive further attention.

**PYRITIC ZINC-LEAD AND COPPER DEPOSITS
(MT. READ TYPE).**

These deposits are not confined to Mt. Read, but also occur on the southern slopes of Mt. Black. There are two distinct varieties, which, however, are so closely connected that it is most convenient to consider them together. These are—

- (a) Zinc-lead sulphide bodies (containing a little copper).
- (b) Pyritic copper deposits (containing a little zinc and traces of lead).

The zinc-lead sulphide deposits consist of large masses of zinc-lead sulphide ore, carrying a little copper and appreciable quantities of the precious metals. The total gross value of the greater part of the ore ranges between £3 and

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£8 per ton, and, as about two-thirds of the value is represented by the zinc, it is evident that, before the whole of the deposits can be worked, a process must be found which will yield the zinc in the form of a marketable product.

It is beyond the scope of the present report to discuss the possibilities of the solution of the zinc problem. It is well known that a number of eminent metallurgists are engaged in carrying out researches in connection with it, and several have expressed themselves as confident of ultimate success. The Tasmanian Copper Company has made an exhaustive examination into a number of proposed processes, and it is now stated that it is about to export a large parcel of its ore for experimental purposes. It is to be hoped that its perseverance and energy will be rewarded with success.

In some of the mines, as, for example, the Hercules and the Mt. Reid, there are limited though still considerable quantities of richer zinc-lead sulphide, which yield a fair profit, even under present conditions. This does not, however, alter the fact that for the successful operation of the great mass of the zinc-lead sulphide ores, a new process is necessary.

At the Hercules Mine, there are also large deposits of low to medium-grade pyritic copper ores, which present a separate mining proposition. There are no metallurgical difficulties to be overcome in the treatment of these ores, and their successful working depends only on the quantity and quality of the ore which is available.

The ore-bodies in the several mines are so similar in character, that it will be most convenient to deal with their geological features as a group before describing the mines in detail.

The rock in which the ore bodies occur consists of schists, of which there are a number of varieties. These may be briefly described as silicious, argillaceous, and calcareous. The general strike of the country is about 12° W. of N., and the dip to the east, at angles varying from 55° to 70°. The silicious varieties of schist, though frequently containing a considerable amount of mineral matter (pyrite, blende, and galena), in the form of an impregnation, have not, so far, been found to contain any mineral deposits of value. The latter are confined to the argillaceous and calcareous schists, and it appears that, of the argillaceous schists, those which have undergone the least metamorphism are the most favourable to deposition. The calcareous schists, which are always associated with the argillaceous, appear to have a very close connection with the zinc-lead sulphide

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bodies; indeed, I have found them either within, adjoining, or immediately adjacent to every deposit which I have examined. As I believe these rocks have played a most important part in the deposition of the ore, I will describe them in greater detail. Many of the harder highly metamorphic argillaceous schists contain small round or ellipsoidal blebs of calcite, which are generally about one-eighth of an inch in diameter. Occasionally the calcite concretions have a definite crystalline outline. Thus, on No. 4 tramway, at the Hercules Mine, there is an exposure of a highly metamorphic argillaceous schist, containing rhombohedra (R) of calcite about half an inch in diameter. These appear to have been distorted somewhat by pressure, as the faces are often bent, and facial angles are not always normal. Other concretions of calcite may be seen on the track between No. 4 and No. 5 levels. These consist of large round masses the size of cannon balls, weathering brown, and containing, besides calcite, a good deal of quartz. I think this quartz is probably due to a secondary replacement of the carbonate of lime by silica, for there are other types of calcite concretions which appear to have suffered a similar alteration. Thus, on No. 4 tramway, there is an exposure of argillaceous schist containing small ellipsoidal blebs of quartz, the exact counterpart of the calcite blebs from other parts.

Most of the calcareous schists differ from these argillaceous schists only in the abundance of the calcite blebs. Viewed in a direction at right-angles to the folia, they may readily be mistaken for argillaceous schists; but when the cross-fracture is examined, they are seen to be composed of multitudes of lens-shaped particles of calcite, separated from each other by a thin film of argillaceous material. Calcite schist appears to me to be an appropriate name for this rock. Perhaps the most typical example is to be found in the No. 3 tunnel, at the Hercules Mine. By decrease of the argillaceous matter, the rock passes over into a fine-grained crystalline limestone, and, by a decrease of the calcite, into argillaceous schist. The calcite schists are by no means persistent, either in strike or dip. Thus, at the Hercules Mine, in No. 3 tunnel (see Plate II.), calcite schist is very abundant. In No. 4 tunnel, 50 feet lower, it is distinctly less so; and in No. 5 tunnel, which is 200 feet lower than No. 3, there is no calcite schist in that portion of the tunnel which is below No. 3 and No. 4 tunnels. Further in it re-appears, but these are evidently separate bands. In strike, also, the bands of calcite schist appear to die out and come in again. Thus, no connection appears to exist between the bands of

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calcite schist in No. 2 tunnel and those in other workings further south. Each band appears, therefore, to be a separate lens dying out both in strike and dip. I think that the most probable explanation of the facts of the occurrence of these calcite schists is, that they are of concretionary origin, the lime being concentrated along certain planes from the adjoining strata, all of which may have been more or less calcareous. In the vicinity of the ore-bodies the calcite schist is sometimes very nodular, the individual nodules going up to 3 inches in diameter. Very often the calcite is here replaced by rhodochrosite, or, more frequently, by an isomorphous mixture of carbonate of lime and carbonate of manganese.

The period at which the formation of these concretionary bands of calcite schist took place was probably prior to or contemporaneous with the metamorphism of the schists. As direct evidence of this, the distorted crystals of calcite on No. 4 tramway at the Hercules Mine may be referred to. The general ellipsoidal form of the other calcite blebs may also be due to distortion during the process of metamorphism.

Throughout the belt of schist country in which the zinc-lead sulphide ores occur there are numerous bands of keratophyre. At Mt. Reid one of these occurs to the east of the ore deposits, and has been penetrated by the No. 2 tunnel of the Hercules Mine for a distance of about 25 feet. The contact between this rock and the schists is very obscure, owing to the fact that the keratophyre is distinctly schistose at this point, while the schists are slightly crystalline. The latter may possibly be due to contact metamorphism. At Rosebery there is a very massive belt of keratophyre, or an allied rock to the east of the mine. The water-race of the Tasmanian Copper Company traverses this rock for about two and a half miles. There are also numerous dykes of keratophyre in the schist to the west of this mass.

At the Hercules and Mt. Reid mines the whole country appears to be cut up by a network of slides and minor faults. A number of these are shown on the plan of the Hercules Mine (Plate II.), but it is unlikely that I have succeeded in noting, in the ground opened up, more than a small proportion of the slides actually in existence. Many of the slides are very flat, and nearly all of them dip towards the east or north-east. In many places there has been considerable movement of the country, as shown by the non-continuance of certain bands of schist on both sides of the slides. The ore-bodies have also been affected by the movements to some extent, as shown by the workings in the

stopes in places. Many of the ore-bodies are very much broken up by joints and slides passing through them. In some places curious open cavities, evidently water channels, have been found running through the solid ore.

The ore-bodies are invariably accompanied by a curious type of mineral vein, which I have also noticed in connection with the North Lyell ore-deposit. The veins are usually quite small, not more than two or three inches wide, but, occasionally, they go up to about 18 inches. They are composed principally of quartz, with rhodocrosite and calcite, or with isomorphous mixtures of these minerals; further, crystalline chlorite, and occasionally a little purple fluorite. Metallic minerals occur sparingly; they are represented by copper pyrites, zinc-blende, and galena. The quartz and rhodocrosite, or calcite, generally occur in interlocking fibres, about an eighth of an inch in thickness, crossing the vein at right-angles to the walls. At the surface, the carbonates of lime and manganese and the metallic minerals have generally been leached away, leaving the quartz fibres alone as the vein-filling. The veins have then a very characteristic honey-combed appearance. These veins will, I think, prove of geological importance in connecting the sulphide deposits of Mt. Read and Rosebery with the Mt. Lyell deposits.

In mineralogical composition the ore-bodies consist of a mixture of iron pyrites, zinc-blende, galena, and a little copper pyrites. In the richer ore fahlore is present in small quantities, and occasionally traces of bismuth have been found. The several minerals forming the bulk of the ore-bodies often form an intimate mixture, in which the naked eye fails to recognise the separate minerals. In other parts the component minerals are less finely divided, and sometimes they are quite separate. With the exception of the very dense ore, the ore-bodies exhibit a finely laminated structure parallel to the strike and dip of the surrounding schists. They often contain a considerable proportion of argillaceous material. I believe that every gradation may be found between the practically barren schist slightly impregnated with mineral matter and the dense pyrites or the zinc-lead sulphides.

The ore differs very greatly in the proportion of the metals present. Sometimes it consists of practically barren iron pyrites; this again often contains bands of ore composed of an intimate mixture of iron pyrites and zinc-blende. These bands are generally parallel to the laminae of the ore, but if the pyrites is quite dense, the blende-pyrite mixture forms irregular veins or bunches in the pyrites. Sometimes

the whole mass of the ore is composed of this blende-pyrite mixture. By addition of galena and diminishing amounts of pyrite this passes over into the normal zinc-lead sulphide. With the galena and blende comes usually, also, the silver and gold values, which only exist in traces in the dense pyrite. The gold appears to be present in the zinc-lead sulphide in the metallic state. Mr. S. Thow, Manager of the Hercules Mine, tells me that his sale samples contain on an average 0.03 to 0.04 oz. per ton of metallics on a screen of 80 holes to the running inch, and some parcels have gone as high as 0.145 oz. per ton. Occasionally a little silver is found as metallics, but this is not usually the case. The silver appears to be present in the fahllore. Mr. Luke Williams, the late Mine Manager of the Mt. Reid Mine, tells me that in selecting the richer ore to send to the Tasmanian Smelting Company, he always followed the ore in which this mineral was showing. This theory has been verified by special assays of fahllore at the Mt. Reid, the Hercules, and the Tasmanian Copper Company's mines, selected samples having gone as high as 2000 ounces to the ton; whereas, selected samples of the other metallic minerals generally go very low in the precious metals. Very rich assays for gold have also been obtained from the fahllore. Non-metallic minerals are nowhere abundant in the deposits. Occasionally a little baryta is present in the ore, and sometimes this occurs in fair-sized masses. Flourite is occasionally found in very small quantities. The presence of calcite and rhodocrosite has already been referred to; these do not, however, usually occur in the solid ore.

As regards the relative abundance of the metals at varying distances from the surface, very little can as yet be said. At the Tasmanian Copper Company's mine the ore-body strikes approximately at right-angles to the slope of Mt. Black. Backs are gained rapidly by driving north on the ore-body. In the drive north from the lower tunnel the ore appears to be getting poorer in zinc and lead as depth is gained. At the Hercules Mine the evidence is not very decisive, and is somewhat contradictory. In No. 5 tunnel none of the zinc-lead sulphide bodies have been cut, but it is not known whether this is because they do not live to that depth, or whether it is because they have pitched to the north. As regards the precious metals, there is a certain amount of evidence that these decrease in quantity as depth is gained. In No. 1 lode rich sulphide ore was mined several years ago, above No. 1 level. 62 tons of ore, assaying over 2 ozs. of gold and 68 ozs. of silver per ton were won.

Ore is now being stoped between the intermediate level and No. 1 level of an average value of—gold, 0.35 ozs.; silver, 450 ozs.; and lead, 17.6 per cent. A part of this difference is probably due to the fact that in the old days it only paid to mine the richest ore, while now the whole ore-body is being stoped out. However, where this lode is cut in No. 2 level all the ore is very poor in the precious metals. I think it may also be said with regard to the other ore-bodies that, as far as they have been proved, there is a tendency for the gold and silver values to decrease in depth. B lode has been cut across, both in No. 3 level and No. 4 level, and in both places it has been carefully sampled every five feet. Plate IV. gives two diagrams showing the the assay-values of this lode at the two levels. It will be at once seen that it is both larger and richer in No. 4 level than in No. 3, while the relative proportions of the metals are about constant. In the case of the Mt. Reid Mine, I understand, from Mr. Luke Williams, the late Mine Manager, that the assay-value of the ore is about the same in the tunnel level as it is in the open cuts at the surface.

Table No. III., containing analyses of ore from the several mines, gives a good idea of the average composition of the ore.

TABLE III.

	I.	II.	III.	IV.	V.	VI.
Gold, ozs. per ton...	0.13	0.23	0.50	0.10	0.12	0.07
Silver " " ...	12.77	10.84	33.10	7.70	7.38	9.43
Copper, per cent...	0.15	0.76	0.59	0.48	0.68	0.76
Zinc " " ...	43.27	24.30	19.80	38.30	16.17	19.57
Lead " " ...	13.88	10.52	11.50	6.80	3.75	2.50
Iron " " ...	10.17	8.64	—	13.70	19.70	15.56
Manganese " " ...	0.42	1.29	4.9	0.4	—	—
Sulphur " " ...	29.53	33.64	—	32.60	34.06	28.76
Alumina " " ...	—	—	—	—	2.30	2.34
Silica " " ...	—	—	21.20	—	16.40	24.46
Insoluble " " ...	3.06	30.30	25.0	6.5	—	—

- i. High-grade zinc ore, Mt. Reid Mine.
- ii. Average of ore in Mt. Reid Mine. Sample taken by Mr. Luke Williams, mine manager.
- iii. Ore from south lode workings, Hercules Mine; assay from bulk shipments.
- iv. Bulk from 9 samples, B lode, north drive, Hercules Mine.
- v. Average of two bulk samples from ore on tip No. 2 level Tasmanian Copper Company.
- vi. Average of two bulk samples from ore on tip No. 4 level Tasmanian Copper Company.

In shape, the ore-bodies at Mt. Read appear to be that of irregularly-lenticular masses, cutting out both in strike and dip, and with the two longest axes approximately parallel to the strike and dip of the schists. They vary very greatly in width, going up to 70 or 80 feet. In the majority of cases, the ore-bodies appear to have been found along planes of movement, but the whole country is so full of slides and faults that it is difficult to determine whether these have been formed before or after the deposition of the ore. At Mt. Black, the ore is more in the form of a continuous ore-body, varying considerably in width, but continuous for a long distance, and, I believe, accurately conformable with the surrounding schists. It appears also that at Mt. Black there has been only one horizon along which ore has been deposited. At Mt. Read, on the other hand, there are quite a number. Several of the ore-bodies at the Hercules Mine have been proved to pitch towards the north.

I have already referred to the argillaceous schists which contain small ellipsoidal blebs of calcite. These same argillaceous schists also occur with similar blebs of brown zinc-blende. Also, in the dense ore, the same blebs of blende are very common. In the Mt. Reid Mine I have found dense low-grade pyrites, with blebs of calcite exactly similar in shape. I have no doubt, therefore, that the zinc-blende is pseudomorphous after calcite.

In the upper portions of all the zinc-lead sulphide bodies, there exist considerable masses of gossan. These appear sometimes merely as a capping of the sulphide ore; at other times, as in the Hercules Mine, as irregular masses in the sulphide ore, while sometimes the sulphide ore occurs as irregular masses in the gossan. In nearly all cases, the dividing-line between the gossan and the sulphide ore is sharp and distinct. The gossan consists of a soft porous mass of iron oxide and clayey matter, with, frequently, crystals of carbonate of lead distributed through it. It also contains a percentage of zinc, probably in the form of carbonate.

At the Hercules Mine, there are, in addition to the deposits of zinc-lead sulphide, considerable bodies of copper ores. It is not yet established what connection exists between these bodies and the zinc-lead sulphide. In No. 3 ore-body, the south end of the shoot appears to be composed of copper ore, but it is not certain that this is not a separate mass, divided from the zinc-lead sulphide by a band of

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schist. In No. 5 tunnel (see Plates II. and III.), a fine body of copper ore, 40 feet in thickness, has been cut through. It is possible that this may be a continuation of B lode, but it is rather too far east, and I am more inclined to think that it is a separate lenticular mass. It consists of bands of highly-impregnated schists and dense ore, all showing copper pyrites very freely. Bulk samples taken every 5 feet have proved the ore-body to contain up to 7 per cent. of copper. For a distance of over 100 feet to the west of this good copper ore, the country consists of bands of more or less highly-impregnated schist, containing in parts a considerable amount of copper pyrites and a little zinc-blende. To the east of the copper, the schist is also impregnated, but not so highly. There are also a few small seams of zinc-lead sulphide at No. 5 level.

As regards the origin of the zinc-lead sulphide bodies, I think that the finely-laminated character of most of the ore, and the facts connected with the passing over of the impregnated schist into the massive ore-bodies, is indisputable evidence that the ore-bodies have been originally formed by the replacement of the substance of the schists with mineral matter. The formation of these deposits may be the result of still another phase in the process of ore-deposition which we already know to have been active in the district. In other words, the metal-bearing solutions may have emanated from the granite magma. In support of this, the presence of small quantities of fluorspar and bismuth sulphide may be referred to. The chlorite in the quartz veins with which these deposits are associated is also evidence of the plutonic origin of the solutions which deposited the ores. Chlorite is rarely met with in the ordinary types of silver-lead veins, but is a common constituent of cassiterite veins. On the other hand, it is quite possible that metalliferous emanations may have taken place from other eruptive rocks in the district, such, for example, as the keratophyre with which the deposits are associated. It is, however, possible that this rock is merely a differentiation product from the granite magma, and, in that case, we would still be right in saying that these deposits belong to the same general process of ore-deposition to which we have attributed other large bodies of sulphide ores in the district. It is to be hoped that these points will become clearer as our knowledge of the West Coast is extended.

But, although I regard it as certain that the original deposition of the ores took place by ascending solutions, I think

that there is very distinct evidence that a concentration of the valuable metals has taken place within the ore-bodies, comparatively recently, by descending solutions. This subject is one which has received much attention during the last few years at the hands of American geologists, and several important articles on the subject have recently appeared among the transactions of the American Institute of Mining Engineers.* As evidence of this, I may mention the presence of bands and patches of the blende-pyrite mixture in pyrite, and the gradual passing over of this, by addition of galena, into the zinc-lead sulphide ore. The presence of pseudomorphs of zinc-blende after calcite, both in the schists and in the dense ore, is also strong evidence of the secondary deposition of this mineral. It is, of course, an open question as to the amount by which the deposits have been enriched in this way, and this point can only be finally settled when the unaltered deposits are opened up.

The conditions for the existence of descending solutions appear to be most favourable, especially in the case of the Mt. Read deposits. Take the Hercules Mine as an example. The mine is situated on the steep western slope of Mt. Hamilton. Below the outcrops of the ore-bodies, the angle of slope of the surface of the ground is about 60° from the horizontal for several hundreds of feet; below this, for nearly a thousand feet, the angle of slope is between 30° and 50°. The strike of the schists and of the ore-bodies make an angle of about 30° with the average direction of the contour lines of the hill at this point. The dip of the schists is to the east, while the hill slopes to the west. The country is intersected by very numerous faults and slides, almost all of which dip to the east or north-east. It is, therefore, evident that much of the water which enters the rocks near the top of the hill must travel downwards through the openings in the rocks for long distances before again emerging at the surface. At the Mt. Reid Mine, the conditions are probably quite as favourable, although the deposit is situated a little further from the steep slope of the mountain. The ore-body at the Tasmanian Copper Company's Mine is probably not so favourably situated as those of Mt. Read, because the strike of the schists and of the ore-body itself is approximately parallel to the slope of the mountain. There would, therefore, be a tendency for the water to flow

* See the papers of Van Hise, S. F. Emons, and W. H. Weed, Transactions Am. Inst. Mining Engineers, Vol. XXX.

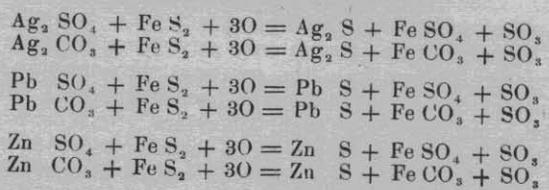
downwards along the ore-body, or along the planes of stratification of the schists, without descending to any great depth.

The first work of the descending surface-waters when they come in contact with the ore-bodies, or with the smaller particles of ore distributed through the schist, is that of decomposition. The chemistry of the process is very complex, and need not be discussed here; suffice it to say that the sulphides of most of the metals are altered to sulphates or carbonates, and in that form are taken off in solution. Sulphuric acid, and, under certain conditions, hydrogen sulphide, are among the decomposition products of iron pyrites. The former is, no doubt, always present at first, but may become neutralised by contact with carbonate of lime. Hydrogen sulphide can only exist when lead, copper, and silver are absent from the solutions, because it would immediately combine with them to form sulphides. Whenever the conditions are such, therefore, that hydrogen sulphide is formed, it is only possible for zinc and iron to go into solution, since these are the only metals present which are not precipitated by hydrogen sulphide in an acid solution. I think the pseudomorphs of zinc-blende after calcite may be satisfactorily explained by the action of such solutions. The calcite would neutralise the sulphuric acid, enabling the sulphide of zinc to be precipitated, and the sulphate of lime would be carried off in solution. Iron sulphide might, of course, also be precipitated in the same way, but not till all the zinc had been precipitated, since zinc has a greater affinity for sulphur than has iron. It is probable that the amount of hydrogen sulphide present would seldom be sufficient to precipitate all the zinc from solution, so that the precipitation of iron sulphide would be rare. In one specimen, taken by me from No. 5 tunnel at the Hercules Mine, I found small blebs of calcite containing crystals of iron pyrites. It is possible that these may have been deposited in this way.

The bulk of the zinc-lead sulphide deposits have, however, been formed by the replacement of iron pyrites, and in this process carbonate of lime probably played an important part, since the deposits are only found in the immediate vicinity of rocks containing this mineral. On theoretical grounds also the presence of carbonate of lime appears to be necessary for the concentration, both of the zinc and lead. Zinc sulphide cannot be precipitated from an acid solution, but the presence of carbonate of lime would ensure the solutions remaining neutral. The originally acid solutions

coming in contact with the carbonate of lime would become neutralised, forming sulphate of lime and carbonic acid. The presence of the latter would then enable a considerable quantity of carbonate of lime to go into solution, and this would ensure the neutralisation of any other acid which would be subsequently formed. The presence of carbonates is also probably necessary to enable the lead to go into solution. Lead sulphate is very insoluble in water, while lead carbonate, which would be formed if carbonate of lime were present, is appreciably soluble in water containing carbonic acid.

The several reactions for the precipitation of the sulphides of the metals by iron pyrites are as follow:—



As regards the order of precipitation, this depends upon the relative affinities of the several metals for sulphur, and also on several other factors. As between the above three metals, the order of precipitation is as follows:—1 silver, 2 lead, 3 zinc. This order will probably be found to be repeated in the metallic contents of the ore-bodies as depth is gained. Silver sulphate is very readily decomposed, and will, therefore, be quickly re-deposited as sulphide, or in combination with sulphur, antimony, and copper, as fahl ore, &c. Lead and zinc salts are more stable, but lead has a strong affinity for sulphur, and will, therefore, be soon precipitated. Zinc has rather a weak attraction for sulphur, and will therefore be precipitated more slowly.

It is of course not to be supposed that the metallic contents of the ore-bodies have been wholly derived from the portions of the deposits which we now see oxidised at the surface. The process is a continuous one, and keeps pace with denudation, so that the metals which are now found in the sulphide bodies may have been derived from hundreds, or even thousands, of feet of low-grade material which has been removed by denudation. Rapid denudation, such as must have taken place both at Mt. Read and Mt. Black, is favourable to enrichment, because it quickly removes the upper, already leached, portion of the deposits, and enables a larger amount of lode-matter to be lixiviated

in a given time than would result were denudation less active.

Although these theoretical considerations go to show that the zinc-lead sulphides must gradually become poorer as depth is gained, the amount of ore actually in sight is so large that this fact need cause no uneasiness. If only the zinc problem can be solved, there is sufficient ore available to keep a very large works employed for many years.

The deposits of copper ores at the Hercules Mine present, I believe, a separate problem. It is perhaps too early to speak definitely yet, but I am at present inclined to the belief that these deposits are in their original state, and have not been enriched by descending waters. Certainly, at present there is no evidence of enrichment. The ore consists of copper and iron pyrites, disseminated through schist, with large bands of practically solid ore. There are none of the rich copper minerals, such as bornite and chalcocite, which are commonly recognised as of secondary origin. Unlike the zinc-lead sulphide bodies, the copper appears to be independent of the presence of lime in the adjoining rock.

The difference in the metallic contents of the two classes of deposits may be due to two causes. It may be due to differences in the levels (or, what is the same thing, differences in the distances from the cooling granite magma), at which the original deposits were formed. It may also be due to differences in the composition of the rocks, some being more favourable for the precipitation of copper, others being more favourable to the precipitation of zinc and lead. Of these two theories, I think the former is more probable. Such changes in the composition of ore-deposits as depth is gained are not uncommon. At the Hercules Mine, copper is very much more abundant in No. 5 level than in any of the others. Further, at Mt. Read all the zinc-lead sulphide bodies are at a great elevation. Lower down, on the western slope of Mt. Read, two ore deposits are known, namely, the Ring P.A. and the Jupiter, in both of which the ore is composed of cupriferous pyrite, with very little zinc, and only traces of lead. The respective heights above sea-level of the outcrops of the several deposits are, approximately, as follows:—Ring P.A., 1540 feet; Jupiter, 1800 feet; Hercules and Mt. Reid Mine, 2900 feet. There is, therefore, much reason to believe that a zone of copper ore may be found below the zinc-lead sulphide zone; and, if this proves to be the case, it will make a very great difference to the future of the district. The presence of payable copper ores would render the mines independent of the solution

of the zinc problem, and enable them to carry on operations pending the discovery of a suitable process for the treatment of their large reserves of zinc-lead sulphide.

The Hercules Gold and Silver Mining Company, No Liability.

This company holds the following sections:—Nos. 89-95, 49-95, 103-94, 100-94, 88-95, 50-95, 101-94, 102-94, held under gold lease, with a total area of 71 acres; also section 1918-91M, 31 acres, held under mineral lease.

The mine is situated on the western slope of Mt. Hamilton, a spur on the west side of Mt. Read. It is connected by a self-acting endless wire-rope tramway with the terminus of the North-East Dundas tramway at Williamsford.

Plate II. gives a sketch plan of the mine workings, together with the positions of the several ore-bodies. Most of this is taken from the excellent plan recently published with the company's half-yearly report. The contour lines have been sketched in partly from data supplied to me by Mr. S. Thow, the mining manager, and partly from barometric readings taken by myself. There are five principal zinc-lead sulphide ore-bodies known on the mine, but some of these may eventually prove to be connected. Further, there are a great many more "makes" of ore in the vicinity of what are now regarded as the main ore-bodies, some of which may, when driven on, develop into large bodies of ore. At present the principal ore-bodies are known as follows:—No. 1 lode, A lode, the south lode, No. 3 lode, or the main lode, and B lode. Besides these there is the surface outcrop of a sulphide lode on No. 4 tramway behind the blacksmith's shop. There are several makes of ore between No. 1 and No. 3 lodes, and between No. 3 and B lodes. There is, further, the copper formation connected with No. 3 lode, and the large copper formation cut in No. 5 tunnel.

The mine workings will, I think, be intelligible from the plan, and need not be further described.

No. 1 Lode.—The rich sulphide ore mined several years ago, and packed in to Dundas, came principally from this lode above No. 1 level. According to the late Mr. J. Harcourt Smith's report, 9 tons 13 cwts. of gossan, averaging over $10\frac{1}{2}$ ozs. of gold and 212 ozs. of silver, per ton, and 62 tons of sulphide ore, assaying over 2 ozs. gold and 68 ozs. of silver per ton, were won. At present stoping is being

carried on between the intermediate and No. 1 level, the ore consisting of both gossan and sulphide, but principally the latter. The average assay value, as published in the last half-yearly report, is as follows:—Sulphide ore—gold 0·35 ozs., silver 45·0 ozs., lead 17·6 per cent.; gossan—gold 1·50 ozs., silver 60·0 ozs., lead 2·4 per cent. The lode is about 10 feet in thickness in the present stopes. At No. 2 tunnel level the lode appears to have split up. The drive north from No. 2 tunnel follows a small make of ore for 100 feet. A crosscut was then driven west, and a much larger body of zinc-lead sulphide was cut through, about 35 feet in thickness. This body has not been systematically sampled, but it is known to be low-grade, and unworkable under present conditions. A rise has been put up in the ore-body between this level and the intermediate, so that there is no doubt that it is a continuation of the ore-body which is now being stoped in the upper levels. In a southerly direction the ore-body appears to lose most of its zinc and lead contents, for in No. 2 tunnel only pyrites and highly-impregnated country was cut.

A Lode.—This is a promising-looking lode in the upper levels, consisting of 10 or 12 feet of gossan, with sulphide ore underfoot. Unfortunately, the latter does not appear to live down, as in No. 2 tunnel only highly-mineralised country is met with. However, the occurrence of the shoots of sulphide ore is so erratic that it is impossible to say definitely whether the ore has given out or whether the tunnel has happened to strike the formation in a poor place. From the surface it has been driven along for a distance of 170 feet, of which 120 feet was in good gossan ore. Stopping operations are now in progress above this drive, the average assay value of the ore won being as follows:—Gold 0·80 ozs., silver 16·0 ozs., lead 2·5 per cent.

The South Lode.—This body of ore has been proved down to No. 4 level. The length of the shoot is about 75 feet. In No. 3 level the average width of the ore is about 5 feet, going up in places to 10 or 11 feet. In No. 4 level the maximum width is 15 feet, but the shoot is somewhat shorter. The ore consists of saleable zinc-lead sulphide, which is now being stoped out and sent to the Tasmanian Smelting Company. The following assay gives the average value of a number of bulk shipments of sulphide ore from the south lode:—Gold 0·5 ozs., silver 33·1 ozs., zinc 19·8 per cent., copper 0·59 per cent. Quite lately an important

make of gossan has been discovered at the surface to the south of the present underground workings on this lode.

Between the south and No. 3 lodes several bands of ore have been cut, both in the south lode crosscut, and in the crosscut connecting the south drive on No. 3 lode from No. 3 tunnel, with the intermediate drive on the south lode. One of these, consisting of 18 inches of sulphide ore, assays—gold 0.2 ozs., silver 12.2 ozs., and lead 16.8 per cent. Another body of pyritic ore met with in the lower crosscut is 5 feet in width, and assays—gold 0.2 ozs., silver 7.0 ozs., lead 17.3 per cent., copper 1.4 per cent.

No. 3 Lode.—This is a curiously complex system of irregular lenticular masses of gossan and sulphide ore. It has been driven on for about 300 feet in No. 3 level and 400 feet in No. 4 level. Above No. 3 level it is largely oxidised, and the greater part of the output of gossan ore during the last twelve months has come from this portion of the mine. The sulphide ore is not high-grade, and most of it is just too low to pay under present conditions, but the gossan leaves a fair margin of profit after all expenses are paid. While stoping is proceeding, it is the practice to drive into the hanging-wall of the lode, with the combined object of obtaining filling for the stopes and of prospecting for other bodies of ore. These crosscuts have in places proved payable gossan to exist for a width of 50 feet, though this is exceptional; nearly all of them have been the means of discovering bodies of gossan or sulphide ore more or less extensive. At the end of the north drive, at No. 3 level, the ore-body which had been driven on appears to pinch out, but a crosscut from the north drive on B lode has quite lately proved that there is a large body of gossan and sulphide ore 25 feet north of this. This is now called C lode, but it will probably be found to have some connection with No. 3 lode. This ore-body was first cut 50 feet to the east of the drive on No. 3 lode, and was followed in a north-westerly direction for 80 feet. This crosscut has opened up a large amount of both gossan and sulphide ore, the existence of which was not known, and promises to add very considerably to the amount of ore in sight. There is a curious make of copper ore in No. 3 lode. It appears to be separated from the zinc-lead sulphide by a band of schist. In No. 3 level it appears on the western wall of the drive for a distance of about 50 feet, and a cuddy has been put into it for about 10 feet without reaching the foot-wall. In No. 4 level the drive follows the western wall of

the body for a distance of 60 or 70 feet, and an easterly crosscut proves the width to be about 35 feet.

B. Lode.—This is a large zinc-lead sulphide body which must await the solution of the zinc problem before the whole of it can be profitably worked, but probably richer portions will be discovered in the upper-levels, which will pay to mine under the present tariff conditions. The ore-body has been intersected by No. 3 tunnel, and by the east winze crosscut at No. 4 level. Between these two levels the width of the ore-body has increased from 25 feet to 54 feet in horizontal measurement. At No. 3 level the ore-body was driven on south for a distance of 25 feet, and north for a distance of 45 feet; beyond this the north drive passes out of the ore, and it is not known whether the ore-body continues to the west of the drive or whether it has pinched out. In No. 4 level no driving has been done along the course of the lode. In No. 5 level, B. lode has not been cut, or, at least, has not been identified. As the shoots of ore in the other lodes have a northerly pitch, it is quite possible that this shoot has pitched north of No. 5 level, and may yet be found by driving in that direction. I think, however, that it is quite possible that the shoot of zinc-lead sulphide does not live to this depth. This will most readily be proved by the contemplated crosscuts from the winze, between No. 4 and No. 5 levels. Plate IV. gives two diagrams, taken from the last half-yearly report of the company, giving the assay values of the ore-body at the two levels.

The Copper Formation, No. 5 Tunnel.—No. 5 tunnel has been driven 250 feet below No. 4 level. For the first 550 feet little else but country impregnated with mineral matter was met with, the zinc-lead sulphide bodies having, apparently, either cut out or pitched north. At about this point the country became decidedly more highly mineralised, with bands of nearly solid pyrites carrying copper pyrites. Some of these bands carry up to 3 per cent. of copper, and, with copper at a good price, should pay for mining. At about 660 feet from the entrance of the tunnel a belt of good copper ore, about 40 feet in thickness, was entered. This deposit consists of bands of highly impregnated schist and dense pyrites, all carrying copper freely. The ore-body has been systematically sampled every five feet, and a diagram showing the resulting assay values is given in the report of the company for the half-year ending 31st July. From this it appears that there is nearly 40

feet of ore, which will average 4.4 per cent. of copper, or, omitting one poor band of 20 feet, which probably would not be taken out when mining operations were being carried on, the remaining 30 feet should bulk 5.3 per cent. To this is to be added the contents in gold and silver to the value of about 5s. per ton at present prices. Little has been done so far with regard to proving the extent of the formation, as, since it has been cut, expenditure in connection with getting the mine into an ore-producing condition has been very heavy; but a start is now being made by sinking a winze on the formation. This has reached a depth of 20 feet with, so far, quite satisfactory results, and I am informed by the mine manager that it is the intention of the company to vigorously prospect the formation. This is certainly the right policy to adopt, as the formation is a very promising one. The existence of a large body of payable copper ore, even if the gross metallic contents are much below that of the zinc-lead sulphide bodies, will add very greatly to the value of the mine, for this ore involves no difficulties in metallurgical treatment, and is not dependent on the solution of the zinc problem.

The East Hercules Sections.—These sections have been lately acquired by the Hercules Company, and it is proposed at some future date to extend the Hercules No. 2 tunnel, with the object of cutting the East Hercules lode. This formation is situated on the east side of Mt. Hamilton, and between it and the Hercules workings is the band of keratophyre already alluded to, which forms the ridge of Mt. Hamilton. The workings were full of water, so that I was not able to examine the formation. The country rock is rather obscure chloritic schist, which will require careful microscopic examination before it can be determined. From an extract from Mr. F. T. Sullivan's report on the prospects of the old company, which is published in the last half-yearly report of the Hercules Company, I note that the mine workings "comprise a shaft 47 feet deep, and a drive from this shaft driven in a westerly direction a distance of 95 feet. At about 70 feet from the shaft the first bands of ore were cut, and from this point to face of drive, a distance of 25 feet, in pyritic schist showing bands and pockets of copper sulphides. These bands are from 3 to 6 inches wide in crown of drive, and from 8 to 15 inches wide on floor." With the object of cutting the formation in depth, an adit was laid out, and has been driven a distance of 202 feet, leaving 203 feet of driving before the shaft is reached.

This will give 116 feet of backs from the brace of the shaft. Assays from the bands of copper ore cut in the drive from the shaft have yielded from 6 to 30 per cent. of copper. The No. 2 tunnel of the Hercules Mine will come under the East Hercules shaft with 530 feet of driving, and thereby will gain 312 feet of backs.

It is, of course, impossible to form a definite opinion without being able to examine the formation *in situ*. Chloritic schists are very commonly associated with copper on the West Coast, and I am strongly inclined to think that the processes of chloritisation and of ore-deposition are very closely connected. At the same time I believe it is a fact that although many promising shows on the West Coast are associated with chloritic schists, none of these have actually proved payable. I think, therefore, that the proposal should be left in abeyance for the present. It is probable that, as our knowledge of the geology of the West Coast ore-deposits extends, we shall be able to come to some more definite conclusion as to the behaviour of copper ores in depth than is possible at present.

The Hercules Company has entered into contracts with the Smelting Company of Australia, Limited, and the Tasmanian Smelting Company, Limited, for the supply of large quantities of both gossan and sulphide ore. Shipments were commenced on the 6th April, 1901, and since that date 7020 tons of gossan ore and 2612 tons of sulphide ore have been delivered. The fulfilment of these contracts will keep the mine employed for between one and two years at the present output, and, as stoping operations have led to the discovery of quite a number of large "makes" of ore, the presence of which were previously unsuspected, it is reasonable to hope that the company can carry on for several years before it comes to an end of its saleable ore. In the meantime it will have proved the extent and value of its copper formation, and, it is to be hoped, will be in a position to work this on a payable basis. The solution of the zinc problem would, of course, add enormously to the value of the mine, as it would enable large quantities of ore, which are now just below the payable limit, to be worked.

The company has selected a site for a smelting works on the banks of the Pieman River, near Rosebery, and propose, eventually, to connect this with its mine by means of a railway and self-acting tram.

The Mt. Reid Mining Company, Limited.

This company holds sections 3302-87M, 80 acres; 4894-93M, 23 acres; 266-93M, 80 acres; and 267-93M, 41 acres. The mine is situated on section 3302, which is directly south of the Hercules Mine, two sections belonging to the South Hercules Company intervening. The other three sections are held for the purpose of securing a site for metallurgical works.

There are two bodies of sulphide ore on the property, which may be described as the eastern and western ore-bodies respectively. The principal workings are confined to the eastern ore-body, which is certainly the largest yet known at Mt. Reid. It is a large lenticular mass between 800 and 900 feet in length, with a maximum width of about 80 feet. This ore-body has been exposed on the surface for a distance of nearly 500 feet by means of a series of large open cuts, and a tunnel has been driven from the north end along the formation. Where first cut the ore-body was quite small, but 150 feet further south crosscuts east and west from the tunnel proved the width to be 74 feet. The ore-body was driven on for 770 feet altogether, and the end of the shoot has not yet been reached. On the surface, however, about 145 feet above the level of the tunnel, and 70 feet further south, the ore-body appears to pinch out.

Analyses Nos. 1 and 2, Table III., were furnished to me by the late mining manager as fairly representing the grade of ore that can be won in bulk. These do not include patches of very low-grade material, which would naturally be discarded when mining operations were being carried on.

The eastern lode has not received much attention up to the present. To the west of the eastern ore-body there is a long ridge, which is believed to form the capping of the ore-body. This consists of partly-decomposed schist, much pitted, as though mineral matter had been leached out. I believe it is the continuation of the belt of country passed through at the entrance of No. 5 tunnel on the Hercules Mine, which at that point was fairly highly charged with mineral matter. The eastern tunnel of the South Hercules is driven in the same belt, and here it is even more highly mineralised, and with a larger proportion of galena than on the Hercules ground. I doubt if this band, which actually forms the ridge, will ever prove to be much more than impregnated schist, but to the west of it there are some calcite schists, in which zinc sulphide ores occur, and which I think are of a much more favourable nature.

The formation has been tested by two prospect shafts, known respectively as Williams' shaft and the west shaft. Williams' shaft, which is situated about 450 feet south and 150 feet west of the open cut workings on the eastern lode, was sunk 50 feet on what was at the surface a narrow band of sulphide ore. The shaft continued in the ore to 50 feet, where it had widened out to 5 feet. On the surface some 30 feet north of the shaft the deposit shows 10 feet in width. A bulk sample of the better class of ore from this shaft assayed—gold 1 dwt. 23 grs., silver 15 ozs. 16 dwts. 4 grs., lead $16\frac{1}{2}$ per cent.; while the bulk of the whole ore taken out, namely, 109 tons, gave the following result:—Gold 1 dwt. 7 grs., silver 6 ozs. 4 dwts. 3 grs., zinc 26·8 per cent., lead 8·5 per cent., and copper 2·0 per cent.

The west shaft was sunk on the same line of country, about 14 chains further north. Quartzite and schist, with bunches of sulphide ore, were struck, from which the following assay was obtained:—Gold 2 dwts. 14 grs., silver 12 ozs. 16 dwts. 2 grs., zinc 14·6 per cent., lead 36·5 per cent., copper 0·6 per cent.

The western formation could be most readily tested by cross-cutting from the tunnel in the eastern ore-body. For testing the ore-bodies in depth there are splendid facilities. From the south-eastern portion of section 266-93M a tunnel could be driven, gaining 1500 feet of backs below the present tunnel-level, with 3300 feet of driving, while from Conliffe's Creek over 2000 feet of backs are obtainable with 1 mile of tunnelling. For reasons which I have given elsewhere, I do not think that the zinc-lead sulphides will be met with at these great depths. On the other hand, I think that the possibilities of finding payable copper ores are sufficient to warrant the ground being tested in depth.

Mr. Luke Williams, the late mining manager, has laid before the directors of the company a scheme for treating the zinc-lead sulphide ore of the Mt. Reid Mine. He proposes to mine the ore in bulk, and divide this into three classes by hand-sorting—

- 1st. Smelting ore containing sufficient values in gold, silver, and lead, to render it saleable under present conditions.
- 2nd. Ore containing over 38 per cent. of zinc to be exported as zinc ore.
- 3rd. Concentrating ore, to be treated by mechanical concentration, winning as final products (a) silver-lead ore, (b) zinc ore.

In order to get some idea as to the possibility of concentrating the ore mechanically, small parcels of ore were tested in the concentrating mills of the Silver Queen and Oonah mines in Zeehan. The mills are, of course, not suitable for the treatment of such ore, and nothing approaching clean products were obtained; but Mr. Williams tells me that the tests proved that there was a decided tendency for the precious metals to be concentrated with the lead, and he regards the results as, on the whole, satisfactory. The ore would have to be crushed very fine, and this would make the loss, not only in the precious metals, but also in lead and zinc, very heavy. At the same time, if the ore could be treated at even a small profit it would be much more preferable than leaving the ore standing. Mr. Williams deserves every credit for bringing forward the proposal, and I think it is decidedly worth giving a trial. A small experimental plant should be erected first, and from the results obtained from this it should be possible to judge of the practicability of the scheme. Much of the ore at the Mt. Reid Mine is not such an intimate mixture that the particles could not be separated by moderately-fine crushing. This does not apply to all the ore, and I do not think it applies to the Hercules ore to as great an extent as to the Mt. Reid ore. There is a large amount of ore in both mines which is so intimately mixed that it appears impracticable to obtain any mechanical separation at all. This class of ore, if it is not rich enough in gold, silver, and lead, to be sold as smelting ore, or in zinc to be exported as zinc-ore, will have to await the solution of the zinc problem before it can be treated. But I think that—at the Mt. Reid Mine, at least, and probably also, to some extent, at the Hercules Mine—there is a proportion of the ore in which the particles of galena, pyrites, and blende are sufficiently coarse-grained to enable a separation to be effected by moderately-fine crushing. The practicability of applying mechanical concentration will depend upon three things:—1. Cost of treatment. 2. The degree of efficiency which is obtainable in the separation of the several minerals. 3. The distribution of the precious metals among the several products. These three points can only be determined by experiments carried out on a working scale on the ore itself.

A machinery-site has already been selected on section 266-93M, and a tramway route connecting this site with the mine has been surveyed and cleared. This will be a self-acting tram, with a fall of 1500 feet in a distance of three-quarters of a mile. There is then 200 feet of fall for the

concentrators between the terminus of the self-acting tramway and that of the branch 2-feet gauge tramway connecting the machinery-site with the North-east Dundas Tramway. This connecting tramway has already been constructed. An ample water supply, both for dressing purposes and for power, has been secured by the company.

The South Hercules Mining Company, No Liability.

Sections 19-95G.L., 9 acres; 23-95G.L., 10 acres; and 5347-93M, 64 acres.

These sections are immediately south and adjoining the Hercules Mine, and north and adjoining the Mt. Reid Mine. Almost at the south-east corner of section 19 a shaft has been sunk on what I presume to be the continuation of the Mt. Reid Company's ore-body. This shaft was under water, and could not be examined. At the surface there is a large heap of sulphide ore, which has come out of this shaft. I am not aware of the assay value, but I fear it is poor, as it is principally composed of zinc-blende and pyrites, with only a small proportion of galena.

At about the centre of this section a tunnel has been driven into the spur, which, further south, separates the eastern from the western formations on the Mt. Reid Company's ground. The tunnel passes through hard silicious schist heavily impregnated with galena, blende, and pyrite, for a distance of 200 feet. This is probably the same belt of country which occurs on No. 5 tramway at the Hercules Mine, but here it carries considerably more galena than it does further north. I think it would be worth while extending this tunnel, because, further south, we know that calcite schists occur to the west of this belt of country, and where this is the case the zinc-lead sulphide bodies are to be looked for. The highly-metalliferous character of the country already passed through may be regarded as a very favourable sign. Near the entrance of this tunnel a seam of sulphide ore was struck, which was followed south for about 80 feet. The maximum width of the sulphide ore in this formation appears to have been about 12 inches. The ore is of good grade, and carries a fair proportion of galena. Near the northern boundary of the section a long tunnel has been put in, with the object of picking up the continuation of any of the Hercules ore-bodies. This tunnel was locked up, and therefore could not be examined. I understand that some sulphide ore was cut near the end of the tunnel, but apparently the formation was not extensive.

The Barlen Hercules Gold, Silver, and Copper Mining Company, No Liability.

Section 30-92G.L., 10 acres. This section is north, and adjoining the Hercules Mine. A good deal of underground work has been done on this section, with, unfortunately, disappointing results. * Several small bodies of sulphide ore were cut by two tunnels, which were driven in an easterly direction into the hill, but they all proved to be short lenticular bodies, cutting out when driven on in both directions. A description of the workings will be found in the late Mr. J. Harcourt Smith's report of 10th June, 1898, on the district.

Dunne's Mt. Reid Mining Company, No Liability.

This company holds sections 218-93M, 44 acres, and 164-93M, 19 acres—both of them south, and adjoining the Mt. Reid Mine. The spur which runs through the Mt. Reid Mine between the two lode formations continues as a low ridge into these sections, and just to the west of it a shaft has been sunk upon what is almost certainly the continuation of the western formation of the Mt. Reid Company. This shaft was full of water, and therefore the ore-body could not be examined *in situ*, but, from an examination of the tip, it appears that the calcite schists observed on the Mt. Reid Mine continue in this direction. These have been attacked by the ore-bearing solutions, for they have been to a great extent converted into carbonate of manganese, and at the surface weather black, owing to the formation of manganese dioxide. Some sulphide ore has been struck, but so far, apparently, not in large quantities. Such as there is, however, is very nice-looking ore, carrying a good percentage of galena. From this shaft the outcrop of the schist has been exposed by a trench in a westerly direction from the shaft, for a distance of 970 feet. Two formations were cut, the first of which consists of a band of mineralised country three or four feet in thickness, carrying zinc-blende, galena, and pyrites. Further west a small shaft has been sunk, from which a little sulphide ore is said to have been obtained. From the end of the trench a long tunnel is being put in to cut the formation which was exposed in the main shaft. This is a big piece of work, and when completed should test the ground effectually. The tunnel is now driven 254 feet, and will require to be driven 715 feet more before it comes below the main shaft. As the formation is dipping to the east, it will then have to go

some distance more before cutting the lode. This tunnel will give about 300 feet of backs. The country passed through up to the present consists of argillaceous and silicious schists, with occasional quartz veins carrying galena and zinc-blende.

The formation on which the main shaft has been sunk is again exposed in a trench by the side of the Mt. Read track. Crystalline limestone occurs here, and some pretty solid pyrites, but I could see no zinc-lead sulphide.

In another part of the report I have referred to the connection which the zinc-lead sulphide bodies have with rocks bearing lime carbonate. These rocks are present on the mine, and zinc-lead sulphide has been found in connection with them, therefore there is no doubt that the essential features necessary for the formation of ore-bodies are present. The formation of large ore-bodies is, however, always more or less accidental, and until they are discovered it is only possible to form an opinion as to the favourableness or otherwise of the conditions. Here, I think, the conditions are distinctly favourable.

The Tasmanian Copper Company, Limited.

This mine has been accurately described by the late Mr. J. Harcourt Smith in his report on the district in 1898, and as no mining work has been done since it will be unnecessary for me to describe it again. The deposit is situated about 5 miles north of the Mt. Read deposits, on the southern slope of Mt. Black. In mineralogical composition it is of essentially the same nature as the Mt. Read deposits, though it is usually somewhat poorer in lead. It differs, however, in that it is more of the nature of a continuous body of ore, since it has been traced for nearly a mile in almost a straight line. It is, of course, not of equal width or richness the whole distance, and very possibly it may form a series of lenticular bodies along one line of strata. The strike of the lode is about 20° W. of N., and the dip to the east at an angle varying from 40° to 60° . The width as exposed in the mine workings is from 30 to 60 feet in horizontal measurement. I did not find any typical calcite schists in the vicinity of the deposit, but some calcite occurs with the ore. I also found a little crystalline limestone on the tip of No. 2 tunnel. It is very likely that the schists originally contained lime, but at present they are almost everywhere very much decomposed.

Tables IV. and V. show the value of the ore in bulk. The analyses in Table IV. are of samples of a shipment of 100 tons, which was exported for experimental purposes. Table V. is taken from the report of Mr. Harold Wilson, the company's engineer, and are the results of analyses of large samples taken by him with the object of ascertaining the value of the ore in bulk.

TABLE IV.—TASMANIAN COPPER COMPANY.

	I.	II.	III.	IV.
Gold, ozs. per ton.....	0·15	0·11	0·36	0·45
Silver, ozs. per ton.....	10·35	10·50	9·24	9·30
Copper, %.....	0·90	0·63	0·75	1·26
Lead, %.....	7·10	5·85	4·00	4·25
Zinc, %.....	27·30	24·75	22·95	18·90
Silica, %.....	7·18	6·10	7·00	6·80
Iron, %.....	18·00	20·25	22·95	24·75
Alumina, %.....	2·20	3·25	3·14	3·20
Lime, %.....	trace	trace	trace	trace
Magnesia, %.....	0·20	0·26	0·22	0·24
Sulphur, %.....	36·24	37·00	38·65	38·95
Undetermined.....	0·88	1·91	0·34	1·65

- i. No. 1 crosscut No. 4 level.
- ii. Between No. 1 crosscut and No. 2 crosscut No. 4 level.
- iii. No. 2 crosscut No. 4 level.
- iv. Between No. 2 and No. 3 crosscut No. 4 level.

TABLE V.—TASMANIAN COPPER COMPANY.

	I.	II.	III.	IV.
Gold, oz. per ton	0·106	0·152	0·116	0·155
Silver, ozs. per ton	7·73	10·35	13·58	8·625
Copper, per cent.	0·23	0·65	0·61	0·77
Zinc "	21·97	23·10	38·86	21·07
Lead "	4·90	3·15	12·65	4·73
Silica "	13·50	8·65	6·10	—
Iron "	20·21	22·14	6·58	—
Alumina "	—	2·10	0·90	—
Sulphur "	35·21	38·06	29·58	—

- i. Average of several bulk samples taken throughout No. 2 level.
- ii. Average of several bulk samples taken throughout No. 4 level.
- iii. Average of three bulk samples of selected zinc ore.
- iv. Average of 25 large bulk samples, representing the whole of the ore in sight.

The deposit of ore, as has already been remarked elsewhere, strikes approximately parallel with the slope of Mt. Black. It is evident therefore that the conditions which regulate the flow of surface-waters are essentially different from those obtaining at Mt. Read. The waters will have a tendency to flow along the deposit without going to any great depth, and will therefore produce a relatively shallow zone of enrichment. Of course it is possible for channels to form underground along the lode, and in this way for enrichments to take place down to great depths, but these, if they occur, must be regarded as accidental, and certainly cannot be depended on. As far as mining operations have gone yet, the ore-body is clearly within reach of the surface-waters, for the schists are nearly all somewhat decomposed, showing that they have been affected by the same waters which have caused the concentration of the zinc and lead. In the north end of the drive from No. 4 tunnel, *i.e.*, the deepest point at which the ore-body has been exposed, the ore carries a larger proportion of pyrite and a smaller proportion of blende than elsewhere, and I take this to indicate that at this point the workings are already getting out of the enriched zone. This point is about 260 feet below the surface.

As has already been pointed out, observations at the Hercules Mine and elsewhere point to the presence of a zone carrying copper ores, below that of zinc and lead, and the question naturally arises as to whether it would not be worth while testing the ore-body for copper at a depth. This can be done by sinking or by boring with the diamond-drill, and considering that the lode has been proved to be fairly continuous on the surface, I am of opinion that the latter course would be the correct one to pursue. The drill should be capable of boring to at least 1500 feet, and probably several bore-holes would be required to test the deposit thoroughly. Taking into consideration the magnitude of the deposit, and the reasons there are for believing that copper will be found in greater abundance in depth, I think that the comparatively small expenditure which this course would involve is fully justified. At the same time it is only right to point out that the existence of a copper-bearing zone, below the zinc-lead zone, has not yet been proved, and that, even if it does exist, it does not necessarily follow that payable ores will be found below every zinc-lead sulphide body.

The North Tasmanian Copper Company, No Liability.

Section 191-93M, 40 acres. This section is north, and adjoining the Tasmanian Copper Company. The workings were closed at the time of my visit, and I therefore did not see them. A good deal of exploratory work has been done, and the Tasmanian Copper Company's lode has been located. It does not, however, appear to be continuous right through from the Tasmanian Copper Company's workings. The lode is smaller on this section than where it has been exposed further south, but the metallic contents are about the same.

The Primrose Mine.

Section 63-93M, 10 acres, and section 240-93M, 16 acres. The sections are situated south, and adjoining the Tasmanian Copper Company's Mine, and the ore-body of the latter company continues into these sections. The lode has been intersected by a tunnel some 5 chains south of the northern boundary, and from this a drive has been put along the ore-body for a distance of about 260 feet in a northerly direction. The drive follows approximately the hanging-wall of the lode, and from this two crosscuts have been driven to the footwall. The width of the ore-body as shown by these crosscuts and the tunnel varies from 12 to 24 feet in horizontal measurement. The three analyses given in Table VI. have been kindly given to me by Mr. C. M. Henrie. They are from bulk samples of the Primrose ore.

TABLE VI.—PRIMROSE MINE.

	I.	II.	III.
Gold, oz. per ton	1·35	0·12	0·16
Silver, ozs. per ton	9·15	7·38	15·60
Lead %	13·50	9·50	9·00
Copper %	0·68	0·65	0·60
Zinc %	30·20	33·50	31·80
Iron %	6·38	11·66	11·15
Silica %	20·25	11·40	12·80

From this it will be seen that the general average of the ore is somewhat higher in gold, silver, lead, and zinc than that of the Tasmanian Copper Company.

The Jupiter Mining Company, No Liability.

Sections 409-93M and 401-93M, total area 40 acres. This mine is situated a little over a mile to the north-east of Williamsford, the terminus of the North-East Dundas Tramway. A first-rate macadamised road, connecting Williamsford with Rosebery, passes within 10 chains of the mine workings. At about the centre of this property there is an outcrop of schist impregnated with iron and copper pyrites, which has been tested by means of a tunnel at a depth of about 120 feet. The tunnel is driven on a bearing of S. 70° W. At 120 feet from the entrance a vein of solid cupriferous pyrites was cut, which strikes 15° west of north, and dips at a high angle to the east. On the south side of the drive a chamber was made and a winze sunk on the vein. In the south end of the chamber the vein is 9 inches in width near the roof, and 15 to 18 inches wide near the floor, while on the north side of the drive it is only about 6 inches wide. I am informed by Mr. H. Brickhill, who was the mining manager for the company, that it increased to about 2 feet in thickness in the winze. It appears therefore to be increasing in size going south, and also in depth. The ore is of good grade, and should carry from 7 to 9 per cent. of copper. This vein looks as if it would make into a larger body of ore if driven on in a southerly direction. The tunnel is continued for about 200 feet beyond this vein. Several bands of pyrites and heavily impregnated country are passed through, but these are all of a much lower grade. The largest of them was cut at about 300 feet from the entrance, and short cuddies were made on either side of the tunnel. The north cuddy entered decomposed country with seams of gossan, but the face of the south cuddy is in dense pyrites. I think it would be well worth continuing this drive south to prove the formation.

Section 252-93M, 40 acres.

This section, formerly known as the Ring P.A., is now owned by the Tasmanian Copper Company. It is situated about half a mile to the north-west of Williamsford. No work has been done on this section for some years, and as there was no one on the ground to show me over the mine, I was not able to make a detailed examination. However, as I visited the mine some years ago, when work was in progress, I can give a short general account of the ore occurrence.

The ore-body consists of a band of iron and copper pyrites deposited as a replacement of the country rock along the line of a fault-fissure. On the footwall of the lode the schist is often heavily impregnated with pyrites. There is also a little barite associated with the ore. The strike of the lode is approximately parallel to that of the schists, *i.e.*, a little to the west of north. I am not aware of the actual length of the shoot of payable ore proved, but I believe it is something over 100 feet. The width varies from 18 inches up to 4 or 5 feet. The following short account of the mine workings is principally taken from Mr. Harcourt Smith's report:—A shaft 50 feet in depth has been sunk on the outcrop of the formation. This passed into the foot-wall country, and from the bottom a crosscut was driven to the hanging-wall, when a band of copper ore was struck 18 inches to 2 feet in thickness. 137 feet below this shaft, No. 1 tunnel was driven on a course of S. 55° W. The hanging-wall of the lode was cut at 220 feet from the entrance, and a good shoot of ore was found. This pinched out when driven on in a northerly direction, in 25 feet. The south drive follows the shoot for some distance; 22 feet from the tunnel a winze was sunk 15 feet, and some good ore obtained, but water prevented further progress. At 38 feet a rise has been put up, connecting with the crosscut from the vertical shaft, and at 50 feet a crosscut has been driven 22 feet towards the foot-wall, passing through 3 or 4 feet of solid ore. The drive continues along the hanging-wall, showing a little ore in places and a good deal of baryta.

No. 2 tunnel has been put in 100 feet below No. 1. This winds about a good deal, following walls and planes of movement in the country, till, finally, it does cut the lode, which has been driven on for a short distance. It is small—not more than a foot or so in width—but contains very nice-looking copper pyrites.

Mr. C. M. Henrie has kindly furnished me with the results of analyses of the ore from this mine, contained in Table VII.

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TABLE VII.—RING P.A.

	I.	II.	III.	IV.	V.
Gold, ozs. per ton	trace	trace	trace	trace	0.03
Silver, ozs. per ton	1.75	4.20	3.00	2.70	1.74
Copper, %	8.76	8.49	5.60	4.38	14.99
Iron, %	31.98	31.5	29.40	39.90	29.06
Silica, %	18.48	16.5	27.00	7.55	15.10
Zinc, %	0.50	1.5	1.25	trace	1.30
Lead, %	trace	nil	nil	nil	trace
Sulphur, %	37.95	—	—	—	33.10
Bismuth, %	trace	—	—	—	—
Antimony, %	trace	—	—	—	—

- i. Average of 15 or 20 samples from the mine.
- ii. Sample from ore-shoot in No. 1 level.
- iii. Sample from ore-shoot in No. 1 level.
- iv. Bulk of all the ore exposed in No. 1 level.
- v. Sample of picked-ore from "A" rise, No. 2 level.

The Tasmanian Copper Company purchased this mine with the object of mixing the ore with their zinc ores at Mt. Black. There is undoubtedly a payable shoot of copper ore here, provided there were local smelters to treat it, and even without local smelters a large quantity of the ore should pay to take out. But, as in the latter case, only the high-grade ore could be mined, it is evidently better policy to wait until it is finally decided whether local smelters are to be erected or not.

FAHLORE AND GALENA VEINS.

There are a number of different types of fissure-veins in the North Dundas district, containing either fahlore or galena as the principal constituents of value. Although it is impossible to draw any sharp lines of distinction, I think it is possible to recognise the following main types:—

- (a) Sideritic Fahlore Veins (Curtin-Davis type).
- (b) Sideritic Galena Veins (Zeehan type).
- (c) Dolomitic Galena Veins (Kapi type).
- (d) Silicic Galena Veins (Owen Meredith type).

The sideritic fahlore veins are found in what is known as the Curtin-Davis district, that very hilly and often almost precipitous region south of the Township of Ringville. The prevailing rocks are slates, greywackes, breccias, conglomerates, and a curious quartz feldspar porphyry, occurring in irregular intrusions in the sedimentary rocks. The

deposits are true fissure-veins, containing small but often very rich shoots of argentiferous fahlore, and probably other compounds of silver, copper, and antimony, such as polybasite, included here under the local term fahlore. In addition to fahlore there is usually present, in greater or lesser abundance, pyrite, chalcopyrite, arsenopyrite, jamesonite, galena, zinc-blende, bismuthinite, and other rare compounds of bismuth. Native silver rarely occurs. The veinstone is principally carbonate of iron, with occasionally some rhodocrosite, barite, or quartz. Iron pyrites is very abundant in some of the veins, and indeed some of the fahlore mines are simply large iron pyrites veins containing small shoots of fahlore. In these cases the pyrites has often replaced the wall-rock to a large extent. Where much pyrites is present there is usually very little carbonate of iron, but still it is always present to some extent. Most of the veins strike a little west of north, and dip at very high angles to the east. Several of them have been traced for long distances almost in a direct line.

By the addition of galena these veins pass over into an intermediate type between the sideritic fahlore veins and the sideritic galena veins, and as the two main types and the intermediate type occur in close proximity to one another there can be no doubt that the one passes over into the other. The sideritic galena veins are composed essentially of galena and carbonate of iron, with often a good deal of jamesonite and zinc-blende, a little chalcopyrite and pyrite, and occasionally a little bismuth. The symmetrically-banded structure so characteristic of fissure-veins is often present. In other cases the wall-rock has evidently been replaced metasomatically, and the galena occurs in the form of bunches and tongues in the slate.

The dolomitic galena veins in this district have not so far proved of commercial importance, but, as in other parts of the West Coast, galena veins, with a dolomitic vein-stone, have proved of great value, it is important to record the main facts of their occurrence. So far as I have observed them these veins are closely associated with the basic eruptives gabbro and serpentine. They occur either in these rocks or in their vicinity. Very often they are found at the contact of the gabbro or serpentine with the sedimentary rocks. The veins contain galena, zinc-blende, iron and copper pyrites, and sometimes antimonial ores, associated with a vein-stone of dolomite, usually more or less carbonate of iron, and sometimes quartz. In one instance, on the Commonwealth section, I found some fluorspar in a small

vein of dolomite and galena. The galena is not usually very abundant, and is rather poor in silver. In some cases the dolomite forms masses of great thickness in the serpentine or at its margin. These masses often contain a few bunches of galena and copper pyrites, but they appear to be of no value. They are often capped by an immense gossan blow, derived, no doubt, from the decomposition of the carbonate of iron. These gossan blows have often been taken for the capping of a big lode, and have been driven under with disappointing results.

The silicic galena veins are not abundant, the only occurrence which came under my notice being the lode of the Owen Meredith and adjoining mines. This is a fissure-vein composed of galena, native silver, a little fahlore, pyrites, &c., in a vein-stone of quartz, with a little carbonate of iron. A description of the mine will be given later.

It is quite possible that the several types of fahlore and galena veins may not be all connected. The dolomitic veins which are associated with the basic rocks may have no connection with the other types of veins, which appear to be quite independent of the rocks in which they occur. There is also very little evidence at present to show that the silicic galena veins are connected with the other types, but in the case of the sideritic fahlore veins and the sideritic galena veins I consider that the intermediate types between these two furnish abundant evidence that they have had a common origin. If, now, we compare these fahlore and galena veins with the zinc-lead sulphide bodies of Mt. Read and Mt. Black, we find that there is a very remarkable analogy between them as regards their mineralogical composition. There is not a single element (with the possible exception of fluorine), and hardly a single mineral, which is not common to both types of deposit. It may therefore be said that they differ only in two respects, namely, (1) in the proportion of the different elements present, and (2) in the mode of occurrence of the deposits. Both of these points of difference are readily explainable on the theory that the two types have been deposited by the same solutions. It seems therefore highly probable that the majority of the types of ore deposits of North Dundas are not independent geological formations, but represent local modifications of one great process of ore-deposition which is intimately connected with the granitic eruption.

The Curtin-Davis District.

There are a great number of sections to the east and south of Ringville on which veins of fahlore and galena have been found and worked on a small scale, with more or less success. Many of these are abandoned now, and on many others no work was going on at the time of my visit. With the exception of one mine, all the mining which is being carried on is either the work of small parties of tributors or of parties of working miners, who have taken up the sections after these had been abandoned by the larger companies. I only visited a few of the sections, as there are very few new developments since the district was reported on by Mr. J. Harcourt Smith.

The Curtin-Davis Mine.

At the time of my visit the party of tributors which is working at this mine happened to be absent, so I did not go over the workings. A detailed description of them, however, will be found in Mr. Harcourt Smith's report. Since the company ceased work there have been one or more parties of tributors continuously at work on the mine, who have generally been able to make wages, and several parties have made a good deal more. The ore occurs in small rich patches, and those who have had the luck to strike ore have done very well.

The Ring Valley Mining Company, Limited.

Sections 1400-91m, 4736-93m, 4661-93m, and 3049-87m, total area 287 acres. This mine is situated on the banks of the Ring River, about a mile south-east from Ringville.

There are three lodes known in the north-eastern portion of section 1400, from one of which (No. 1 lode) £4000 worth of ore is said to have been won by a party of tributors. With the object of testing these lodes below water-level, the present company sank a main shaft to a depth of 110 feet, and at 100 feet opened out. The shaft is sunk on No. 2 lode, which continued in the shaft from the surface. It consists principally of iron pyrites, with patches of fahlore and copper pyrites through it. The ore appears to be pitching to the south, as, when driven on in this direction, it dipped underfoot about 25 feet from the shaft. The lode was driven on for a further distance of 50 feet, but, with the exception of a few splashes of fahlore and copper pyrites in one place, the lode is barren. The strike of this lode is 18° W. of N., and the dip vertical.

From the shaft crosscuts were driven east and west, with the object of picking up lodes Nos. 1 and 3. In the east crosscut No. 1 lode was cut 32 feet from the shaft. This passed through several bands of pyrites from 6 to 8 inches thick, and on the west wall of the lode a band fully 4 feet in thickness was passed through. These appear to be lenticular replacement bodies. The lode was driven on north for a distance of 100 feet and south for 45 feet, and the north drive is being continued. The lode strikes 16° west of north, and the dip is vertical. So far, at this level it has proved practically barren. There are two good walls, with crushed and broken country in between; in one place only, a seam, a few inches wide, of carbonate of iron, and a little iron and copper pyrites, were found. This is particularly disappointing, because this is the lode which (above water-level) was worked by tributors with such excellent results. Mr. J. Moyle, the mining manager, is of opinion that the shoot has dipped to the north, basing his opinion on the presence of certain joints which are to be seen in the west wall, and which dip in that direction. He is now pushing on the drive in order to put this theory to the test.

Twelve feet north of the east crosscut a rise has been put up on the lode to connect with the adit level. From this rise an intermediate level has been driven for a distance of 30 feet north. Within the last 4 or 5 feet some ore has come in, and is showing about 14 inches in width in the end of the drive. It is not very rich, being composed principally of copper pyrites, with some fahllore through it. Further up in the rise, and just below the adit level, a little underhand stoping has been done recently, and some rich ore is showing in the north end of the stope. There is also a big body of iron pyrites exposed at this point. The developments in these workings are decidedly in favour of the theory that the shoot of ore pitches north.

Above the adit level the ore has been taken out by tributors for a distance of about 100 feet. There is a little ore still left near the surface, which is now being stoped out.

No. 3 lode has been cut in the west crosscut from the shaft. This has been driven on for a few feet north of the crosscut. It is a small vein going up to 3 inches in thickness, and composed of carbonate of iron, pyrites, fahllore, &c. In the end of the drive there is about 2 inches of good fahllore showing.

The company has been very unfortunate so far in not finding the ore in its lower level, and it is to be hoped that its perseverance will be rewarded by meeting with

the rich shoot in its north drive. If this is found it will have a block of ground which should pay for a very large amount of development work.*

The Fahlore Silver Mining Company, No Liability.

Sections 3212-87M and 3692-93M, each 80 acres. These sections are situated north and adjoining No. 1400-91M, belonging to the Ring Valley Company. No one was at the mine at the time of my visit, but Mr. John Moyle kindly accompanied me through the mine workings. I am also indebted to Mr. W. Watson, the late mine manager, for much of the information contained in the following notes.

The main lode of the Ring Valley Company runs through the southern section of the Fahlore Mine, and most of the mine workings are confined to this lode. It has a very persistent strike of 10° west of north, and dips very steeply to the east. The old mine workings are situated near the south-eastern corner of section 3212. A shaft was sunk to a depth of about 100 feet below the level of the Ring River, in the bed of which the lode outcrops. The lode was cut in a crosscut from the shaft, and driven on for about 150 feet. The shoot of ore, which at the surface outcrops in the bed of the creek, proved to be pitching north. It was very patchy, but a good deal of rich ore is said to have been obtained from it.

* Since the above went to press the Ring Valley Company has had an important development in its lowest level. The north drive on No. 1 lode has been continued for a distance of 120 feet from the east crosscut, and from this point a crosscut was put in in a north-westerly direction, with the object of testing No. 2 lode and the country between No. 1 and No. 2 lodes, all of which had been proved to be highly mineral-bearing by the east crosscut from the shaft; 24 feet west from the main drive north a shoot of fahlore and copper pyrites has been cut, which Mr. Moyle tells me looks very promising. The crosscut has just cut the south end of the shoot, and, although it has only been opened up for a total distance of 6 feet, 76 bags of ore have been won, which are estimated to yield 150 ozs. of silver per ton. This shoot is dipping to the east, and should intersect the main lode about 40 feet below the present level. The junction is a likely place to find a rich shoot of ore, and it is to be hoped that the company will continue its shoot, so that this ground may be tested.

It may also be mentioned that the Ring Valley Company has recently purchased the Fahlore Mine. There is no doubt that this is a move in the right direction, as the known shoot of ore in the southern workings of the Fahlore Mine can be most conveniently worked from the Ring Valley shaft.

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The main tunnel was driven in a northerly direction from a point 350 feet north of this shaft. In this tunnel the lode consists mainly of iron pyrites from 1 to 2 feet in thickness. At 120 feet a small shoot of ore was met with, which was stoped out. The lode was followed for a further distance of 150 feet in a straight line from the entrance. At this point it appeared to turn a little to the east, and was followed in this direction for 80 feet. It then became apparent that the tunnel had got off the true course of the lode, and a short crosscut was put in to the west. After being driven 10 feet this crosscut intersected a shoot of ore, which was driven on north and south, and proved to be 60 feet in length. This shoot is stoped out above the tunnel, but it only lived to a height of 25 feet. The shoot lives underfoot, and has been proved by a winze sunk in the ore for 21 feet. The lode is 4 feet wide in the bottom of the winze, and consists of 18 inches of pyrites, with fahlore through it, the remainder being slaty lode-matter and pyrites. In sinking the winze 209 bags of good ore were obtained. Six of these gave a bulk assay of 762 ozs. of silver per ton, 22.3 per cent. of copper, and the remaining 203 bags contained 198 ozs. of silver per ton and 5 per cent. of copper. The winze was discontinued, owing to a strong inflow of water. From this shoot of ore the drive has been continued for a distance of 270 feet without further developments of importance.

The intermediate tunnel was commenced at a point 490 feet north of the entrance of the main tunnel, and follows the course of the lode for 543 feet. For the first 270 feet little was found but iron pyrites, but at this point ore came in the floor of the tunnel. This continued in patches underfoot for 60 feet. It then improved considerably, and rose above the level of the tunnel. At about 310 feet from the entrance stoping operations were commenced. The leading stope has been taken out for a distance of 126 feet, No. 2 stope 112 feet, No. 3 stope 69 feet, and No. 4 stope 24 feet. The lode is often very wide in these stopes, and is composed mostly of iron pyrites, with bunches and veins of fahlore in it going up to 12 inches in thickness. In the vicinity of the fahlore the pyrites contains a good deal of copper pyrites through it, and a great deal of second-class ore of this nature has been won which is too poor to sell under present conditions, as there is no market for low-grade copper ores. If copper smelters are started in the district it will make a great difference to this mine, as the low-grade ore could thus be sold at a remunerative price.

There is still fahlore showing in the stopes, but operations have been discontinued pending a reformation of the company. The drive is continued for a distance of 100 feet beyond the stoped ground, but here the lode is poor.

I am told there is a very large outcrop of gossan in the southern portion of section 3692, and a tunnel has been driven through it at a shallow level, but only low-grade gossan was met with. It is intended to crosscut for this formation from the intermediate tunnel.

The South-West Curtin-Davis Mine.

This mine is now leased by Messrs. Ogden and Coady, the section having been thrown up by the old company. The lode, which has been traced for a long distance on the surface, strikes 14° E. of N., and dips to the east at an angle of about 70° . It has been opened up from two adits, driven one above the other, about 100 feet apart, vertically, the upper one being 50 feet below the outcrop of the lode. The lode was driven on north and south from both adits. In the upper level there were two principal shoots of ore, one south of the adit, about 50 feet in length, and the other north of the adit, about 40 feet in length. These have been stoped out above No. 1 adit, and a little underhand stoping has also been done. Altogether about 575 tons of ore were won, realising the sum of £5027 16s. 4d. At the lower level ore was found immediately below both of these shoots, but, unfortunately for the old company, the first two stoped did not pay, and the work was stopped. The present owners started stoping above the south drive stopes, and were fortunate in finding that the lode improved very greatly. They have now a shoot, some 30 feet in length, of solid ore, going up to 15 inches in thickness. The ore carries from 150 to 200 ozs. of silver per ton, and from 10 to 12 per cent. of copper. The party have sold one parcel of 10 tons, and at the time of my visit had another parcel of 14 or 15 tons ready to bag.

The South Curtin-Davis.

This is another mine which has been thrown up by the company which originally worked it. It is chartered in the name of H. Coady and F. Clark. A small syndicate has been formed to further test the mine, and it has had the good fortune to strike, almost at the start, a nice little patch of ore. Three tunnels had been driven by the old

company, which directed its attention principally to a fahlore and galena lode, from which it obtained a large quantity of gossan and a good deal of fahlore and galena. The latter, however, proved very patchy, and apparently did not pay for the exploratory work which was necessary. At any rate, the mine was abandoned. The new owners started driving on a small seam of galena which had been passed through in No. 2 tunnel, and after a few feet had been driven this opened out to a very nice shoot of metal. The ore consists of a very pure cubical galena, assaying 80 per cent. of lead and 17 ozs. of silver per ton. The shoot had been driven on for a distance of about 15 feet at the time of my visit, and showed a maximum width of 10 inches of solid ore. From this 6 tons of practically pure galena had been obtained, and as much more, which will require some dressing before it can be sold. Since my visit Mr. H. E. Hittson tells me that important discoveries have been made by carefully overhauling the old workings. Several formations have been discovered, from which very high assays have been obtained, and it is intended to open up the mine energetically. The ore won to date has more than paid all expenses.

The Great Northern Creek Mine.

Sections 4729-93M, 5312-93M, and 3738-93M, total area 125 acres. These sections are held by Messrs. P. P. Quinn and W. J. Hodge, who have been prospecting them for some time, and have succeeded in locating quite a number of veins of ore. They are situated on the north-western slope of the Carbine Hill.

On section 4729, a few chains from about the centre of the western boundary, a lode has been exposed on the surface for about a chain in length. It is a fissure-vein composed of bands of galena and carbonate of iron from 8 to 10 inches in thickness. The strike is about 60° W. of N., and the dip nearly vertical. About two-thirds of the contents of the vein is galena. From this a parcel of 10 tons has already been sold, the assay value being 64 per cent. of lead and 75 ozs. of silver per ton. About 50 feet south-west of this exposure another smaller vein has been cut. This is about 4 inches wide, and is of the same character as the first.

About 7 chains north-east of this lode there is another vein striking 30° west of north, and dipping to the north-east at an angle of 80° . A short tunnel has been put in

on the course of the lode, but at this point it is only a few inches wide. It has been traced for two or three chains down the hill. At the lowest point it is about 10 inches wide, and is composed of carbonate of iron, with a fair percentage of galena through it. This is not so rich as the other, but it is certainly well worth further attention.

In the southern portion of section 3738, about 20 chains N.W. of the above workings, another very promising galena lode has been discovered. This lode strikes 30° west of north, and dips to the north-east at an angle of 80° . The lode formation is about 4 feet wide, and is composed of bands and patches of galena and slate, with a little zinc-blende, pyrites, quartz, and carbonate of iron. The true width of the formation is difficult to determine, because, even behind what appears to be the foot-wall, there are patches of galena. The seams of solid galena in the lode go up to 6 or 8 inches in thickness. The lode has been opened up for several chains along the surface. At the time of my visit Messrs. Quinn and Hodge were engaged in taking out a parcel of 10 tons. The ore is mostly galena, but some of it is decidedly antimonial, and there is some pure jamesonite. The lode is a very promising one, and is more like the lodes of the Zeehan district than anything I have seen at North Dundas. A small quantity of backs can be got by tunnelling from the creek, but the lode will soon have to be worked from a shaft. I do not think there will be much difficulty with water if ordinary precautions are taken to prevent an influx of surface-water. It may be necessary to flume the creek, which crosses the lode a little to the north of the workings.

To the west of this lode there is a small vein, containing pyrites, fahlore, and galena, striking about 20° W. of N. This lode has been cut by trenches at short intervals for 5 or 6 chains south of this point. Further west still there is a large pyrites lode carrying a little fahlore. This strikes about north and south. The galena lode junctions with this lode a few chains north of the present workings. Near the junction the pyrites contain a good deal of jamesonite and a little fahlore, copper pyrites, and zinc-blende. Sometimes the jamesonite and pyrite are in the form of an intimate mixture, and I think there has probably been secondary deposition of the antimonial lead ore, the latter replacing the pyrites. The ore containing jamesonite is, unfortunately, low in silver, but samples containing fahlore have gone as high as 77 ozs. of silver, with $6\frac{1}{2}$ per cent. of copper. Further north the pyrites lode has been trenched

across in several places, but here it only contains iron pyrites. The pyrite has evidently been deposited as a replacement of the slate, for the structure of the slate is retained in some of the ore, and, although much of the pyrites is very dense, there is a passing-over to be observed from this dense ore to highly-impregnated slate. I think this lode should be sunk on near its contact with the galena lode, as this is a likely place for a rich shoot of ore to be found.

About 6 chains west of the pyrites lode there is a small lode containing arsenical pyrites and a little bismuth sulphide, with a good deal of iron pyrites in the country, the whole formation being about 18 inches in width. There is nothing payable here, but it would be worth trenching along the strike of the lode, in order to locate any shoots of fahllore that may be present.

Besides the above, there are a number of small veins of galena or fahllore on these sections which need not be described here. They are not payable where exposed, but are worth further testing, as it is impossible to say where a rich shoot may occur.

Section 336-93-M, 80 acres.

This section is charted in the name of A. Lucas. In the north-eastern portion of the section two veins have been found. One of these consists of a small vein of galena from 1 to 4 inches in thickness. This is exposed in a trench about a couple of chains in length below the carbine track. This ought to just about pay to take out. I do not look upon it as a lode, but it may possibly be a spur from a larger formation. There is no vein-stone present. About 6 chains north of this a fahllore and galena vein has been trenched on for about a chain in length. The strike is 40° W. of N. This vein varies in width from 3 up to 10 or 12 inches in thickness, and carries carbonate of iron, galena, and fahllore. Some of the latter is said to have gone as high as 180 ozs. of silver to the ton. This vein is worth testing. There are excellent facilities for bringing in a drive along the lode.

Section 4540-93M, 79 acres.

This section is charted in the names of W. P. Margetts, O. Davis, and J. Armstrong, but it is now held by Messrs. Bentley and Everest.

There are two lodes on the section. No. 1 has been driven on for about 200 feet, and two stopes have been taken

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out above the tunnel for a considerable distance. Overhead, soft decomposed country came in, and the ore died out. There is however good ore underfoot, and a lower tunnel is being brought in to work this. The lode is said to have averaged 6 inches of metal, going up to over a foot in places. The strike of the lode is 40° W. of N.

No. 2 lode strikes east and west, and dips to the north at an angle of 67°; this has also been driven on for some distance, and has much the same character as No. 1. The party have sold several parcels of ore from the mine, and are working it at a profit.

The above comprise all the sections which I visited in this part of the district. They represent only a small proportion of the mines which a few years ago were considered to be very valuable properties. The results which have been obtained by Messrs. Quinn and Hodge, Messrs. Ogden and Coady, and Messrs. Bentley and Everest, should encourage other prospectors to go out into this district. There is a large amount of ground now vacant which is well worth prospecting, and on which there is every reason to believe good payable shoots of ore are to be found. From the working miner's point of view this field presents exceptional advantages. The ore is high-grade, and readily saleable, without requiring any expensive method of treatment, while the hilly nature of the country enables most of the lodes to be worked without pumping machinery. When the shoots of ore are found, therefore, little or no capital is required to start operations. It is impossible to go through the district without being struck by the large number of lodes which have been found, and from which payable shoots of ore have been mined. But, besides these, there are scores of sections—such as those on which Messrs. Quinn and Hodge are now working—which were held for speculative purposes during boom times, and on which little or no work has been done. These sections are now vacant, and might be occupied under prospector's licence and thoroughly prospected.

The Five-Mile District.

No mining work was going on in the district at the time of my visit, and indeed most of the ground is vacant. There are a number of promising lodes known, but, unfortunately, the ground is low-lying, and they cannot be worked to any depth without pumping-machinery. During my visit I was accompanied around the sections by Mr. S. Smith, to

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whom I am indebted for much of the information contained in the following notes.

About 8 chains west from the *Madam Melba Hotel* a shaft 28 feet deep has been sunk on what is described as a pyromorphite lode 2 feet 6 inches in width, with 9 inches of pretty solid pyromorphite, the rest being gossan with pyromorphite through it. Thirty feet south of this shaft the lode is exposed in a trench; here it is about 2 feet wide, and composed of gossan and pyromorphite. Some of the ore is said to contain fine needles of chromate of lead, but these I did not find. The strike of the lode is a little west of north, and the dip to the east. From the ore taken out in sinking the shaft a small parcel was sold, realising £2 15s. per ton. The assay value was 2½ ozs. silver per ton, and 52 per cent. of lead. The country consists of a reddish decomposed sedimentary rock, the nature of which is uncertain. From its general appearance I am inclined to think it is a submarine tuff. This lode is situated in the eastern portion of section 3505-93M, close to the northern boundary. The section is now vacant.

A couple of chains to the north-east there is another lode on which a good deal of stoping has been done. This is situated on section 3975-93M, also vacant. This is a similar pyromorphite lode to the last, but it contains patches of chloride of silver. The lode is about 9 inches wide, and strikes 15° west of north. A shaft has been sunk on it for a distance of 37 feet, and the gossan, containing chloride of silver, is said to go down underfoot. Work had to be stopped, however, owing to influx of water. Several parcels of ore were sold from this lode, the price obtained varying from £1 to £33 per ton.

I think it would be well worth while making an effort to test these lodes below the zone of oxidation. The upper portions have evidently been leached of their silver contents, and it is quite probable that they may be found in a concentrated form at or below the base of the gossan zone. To test these lodes a shaft would have to be sunk, probably about 100 feet. A small pumping-plant would have to be erected, and this would have to be driven by steam-power, as I think that water-power is impracticable.

Section 5295-93M, 20 acres, charted in the name of S. Smith.

This section is north, and adjoining No. 3975. A few chains from the western boundary of this section a trench has been made, which cuts across a curious decomposed greenish rock, probably gabbro. At the western

contact of the rock with the sedimentary rocks there is a black puggy lode formation, going up to 5 feet in width. On this a shaft has been sunk to a depth of 18 feet. A seam of galena is said to have been followed varying from 1 inch to 6 inches in width. This is a favourable-looking formation, and is worth further attention. Between this point and the west boundary there are several other lode formations which have not yet been opened up.

Section 306-93M, 39 acres.—This section is west, and adjoining Smith's section, and was formerly held by the McKimmie Silver and Nickel Mining Company. At present it is vacant. About 2½ chains from the centre of the eastern boundary of the section there was discovered a very curious patch of niccolite (arsenide of nickel). It was found in a small but well-defined lode formation, which was traced for several chains along the surface, and contains galena and zinc-blende in small quantities. When found at the surface the patch of niccolite was about 6 feet long and 12 inches wide, and when sunk on it tapered out to almost nothing 6 feet below the surface. The shaft was continued for 26 feet, and proved the lode to contain a little nickel all the way. Two tons of high-grade ore were got out and sent to France for treatment, realising £28 8s. per ton. The country to the east of the lode is black slate, but to the west there is a dyke of decomposed gabbro, and it is possible that the lode may be at the contact.

Section 4976-93M, 80 acres.

This section, which was also formerly held by the McKimmie Silver and Nickel Mining Company, is now leased by the Silver King Prospecting Association, No Liability. It is south and adjoining No. 306, which has just been described. The main lode of the old McKimmie Mine is situated about the centre of the section. The strike of the lode is 5° W. of N., and the underlay 1 in 6 to the east. When the old company started work there was a shoot of ore exposed in the bottom of a deep trench 26 feet in length. This ore was composed of high-grade galena, and the vein averaged about 6 inches in thickness of solid metal. A main shaft was sunk and two crosscuts were driven at distances of 50 and 100 feet from the surface. Where the lode was struck at the 50-foot level it contained about 2 feet of solid ore. The shoot dipped south, and was about the same length in this level as on the surface. Unfortunately, however, it only lived about

10 feet below this level. In the lower level the lode was driven on north and south for 304 feet, and nothing was met with but a strong carbonate of iron lode with a few splashes of galena. As soon as the shoot of ore became exhausted shareholders lost faith in the mine, and it was closed down. The water was very heavy. A 20-inch lift was used, and over 50,000 gallons per hour had to be raised. The ore was worth from £10 to £19 per ton.

The Success and Owen Meredith Mines.

Sections 5093-93M and 5091-93M, each 80 acres.—These sections are charted in the name of J. E. Robertson. They are situated $4\frac{3}{4}$ miles north of the Five-Mile Station on the North-East Dundas Tramway. A large amount of work was done some 8 or 9 years ago by a party of tributors, who constructed over 4 miles of wooden tramway through rough country in order to obtain a means of getting their ore to market. This tramway terminates near the present Argent tunnel on the Emu Bay Railway. From here, in the old days, the ore had to be carted into Zeehan, a distance of 7 miles. A very strong and continuous lode runs through the centre of the property. It crosses what is known as the Crimson Creek, just at the centre of the boundary-line between the two sections. From this point it has been traced, by numerous trenches, in a north-easterly direction, through the northern section, and has been picked up on the eastern boundary of the Bon Accord, which is north-west, and adjoining the former. In the northern portion of the Bon Accord section, and again on the Success Extended, north and adjoining the latter, there are a number of old workings on the course of the same lode. South of Crimson Creek the lode has also been traced for a long distance. It has been driven on for 470 feet, and south of this it has been picked up in the bed of a small creek. Still further south what is probably the continuation of the lode is exposed on section 2539-93M, south-east and adjoining the southern section of the Success and Owen Meredith Mines. The outcrop of the lode has therefore been traced almost in a straight line for a distance of about a mile and a half.

The lode strikes about 32° west of north, and dips towards the east at an angle of 50° to 60° . It varies in width from 1 up to 4 feet. The ore consists of quartz and galena, with a little carbonate of iron, occasionally some iron and copper pyrites, and a little antimonial ore. The galena is not

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solid, but consists of grains distributed through a granular quartz matrix. Some of the ore is very rich in silver, and I think that much of the latter is in the form of the native metal. Native silver is visible in some of the stone, and the several assays of the ore which were made for me showed that the amount of silver bears no constant ratio to the lead contents. The lode is a fissure-vein, with strongly slickensided walls. The best ore is found as a seam from a few inches up to a couple of feet in thickness on the hanging-wall, the rest of the lode being composed of slaty matter and low-grade ore.

North of where the lode crosses the creek it is exposed continuously for about two chains. The lode is here from 3 to 4 feet in thickness, and contains some rich ore, but most of it has already been removed. One sample of the richest-looking ore showing at the surface, taken by me from a seam 3 or 4 inches thick on the footwall of the lode, returned 19.9 per cent. of lead and 265 ozs. of silver per ton. At the end of the trench, about a chain north of where this sample was taken, I took a bulk sample across 2 feet of lode-matter. This returned 4.1 per cent. of lead, 11 ozs. 11 dwts. of silver, and 7 grs. of gold, per ton. About 3 chains north of this trench the lode has been cut by a short tunnel, driven in a westerly direction from the creek. Here it is 3 feet wide, with 15 inches of fair-looking ore on the foot-wall. A bulk sample from this gave a return of 2.3 per cent. of lead and 21 ozs. of silver per ton. Another tunnel has been put in north of this one, but here the lode is practically barren. In driving south from this tunnel a little ore was met with, and a winze sunk upon it. There is a little ore at the mouth of the tunnel, but, of course, any payable ore which was got has been sold. Further north the lode is exposed in several trenches. From the most northerly of these I took a sample from 9 inches of lode-matter, which returned 1.6 per cent. of lead and 34 ozs. of silver per ton. All of the above were fair bulk samples of the ore exposed, and I believe they could have been enriched very considerably by a little hand-picking.

South of the creek a tunnel has been driven on the course of the lode for about 600 feet, and three shoots of ore are said to have been met, but apparently these were too poor to work, for no stoping has been done. I went into the tunnel until a fall of earth prevented me from going further. Up to this point the drive is timbered, and for the greater part of the distance the lode cannot be seen, but in one or two places where it was exposed I saw some

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galena in the stone. Further south still the lode has been picked up in the bed of a small creek. A sample taken from the lode-matter exposed here gave the return of—lead 10·2 per cent., silver 29 ozs., per ton.

A main-shaft has been sunk on the lode, just south of where it crosses Crimson Creek. This shaft cut the lode 50 feet from the surface, and from this point it was continued on the underlay for a further distance of 40 feet. This 40 feet is said to have been all good ore. From the bottom of the shaft the lode was driven on 150 feet north, and from 50 to 60 feet south. Above these levels some stoping was done, and altogether 405 tons 13 cwts. of ore was won, which, delivered in Zeehan, realised the sum of £2485 13s. The assay value of the parcels varied from 4 to 41 per cent. lead and from 32 to 550 ozs. of silver per ton. The majority of the parcels, however, contained between 15 and 30 per cent. of lead and 60 to 110 ozs. of silver per ton.

In the old days the tributors worked under very great disadvantages. The cost of getting the ore to market was very excessive, as after it had been taken over 4 miles of wooden tramway, it had then to be carted 7 miles into Zeehan. Under these circumstances only the best of the ore would pay to take out. The party was also severely handicapped for want of capital. The tramway cost more than had been expected, and the mine had to practically pay for its own development. The result was that, when the first shoot of payable ore was worked out, the mine had to be shut down.

The old tramway is still in very fair order, and could be put into a fit condition for carrying ore with a very small expenditure. By a branch line of about 20 chains in length it could be connected with the Emu Bay Railway within a distance of about 2 miles from the mine.

The silicious nature of the ore from this mine is in its favour, as it may be mixed with the more basic ores of the Zeehan field, and thus replace the silica flux in the furnaces. For this reason the Tasmanian Smelting Company would probably be able to offer a very favourable tariff, and enable the lower grade ore to be worked at a profit.

The conditions therefore for working the mine on an economical basis are far superior now to what they were 9 years ago, and I believe a very large proportion of the ore which had to be left standing then would pay to take out now. The mine will, of course, require capital to start. Pumping machinery will have to be erected, and development work must be pushed on from the start. If this is

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done I think there is every reason to believe that the mine will become a valuable property.

The Bon Accord Mine.

Section 4537-93M, 80 acres. Charted in the name of T. Graham. This section is situated north-west, and adjoining the northern section of the Success and Owen Meredith Mines. The lode which was worked on the latter mine has been traced through the north-eastern portion of this section. Near the northern boundary the lode has been worked by trenches and shallow shafts for several chains, and a shallow tunnel has been brought in from the Success Extended section, which is north and adjoining. There is not much opportunity for observing the lode formation, as the tunnel is timbered, and the old trenches are partly fallen in. Above the tunnel there has been some stoping done, and in the south end of the stopes the lode is exposed. It is composed of a black slate and pug formation, containing several seams of ore, near the foot-wall. A bulk sample from these seams gave 14.8 per cent. lead and 10 ozs. 15 dwts. of silver per ton. There is a little galena at the surface, but all the payable ore which was won from the lode has been removed. The present workings are all shallow, and where I saw it the lode is quite decomposed.

The Success Extended Mine.

Section 5080-93M, 80 acres. This section is north and adjoining the Bon Accord, and the lode passes into it at about the centre of the southern boundary. It has been worked at intervals for 7 or 8 chains from the southern boundary by trenches and shallow shafts, and is said to have been ore-bearing the whole way. There is a good deal of second-class ore at the surface which would require ore-dressing machinery to bring it into a marketable condition. The workings are all quite shallow, as water prevented the lode from being worked to any depth. Before anything more can be done pumping-machinery will have to be erected. This section and the Bon Accord might be worked as one mine with advantage, and a main shaft sunk to test the lode on both sections.

DEPOSITS OF NICKELIFEROUS PYRRHOTITE,

There are two deposits of this class known in the North Dundas district, and, though there is reason to believe that neither of them is of commercial value, it is important that the facts of their occurrence should be recorded, as deposits

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of the same class which are of sufficient dimensions to become of economic value may be found in other parts of the coast.

The most important of the two deposits in the North Dundas district is situated on section 3510-93M, near where the Emu Bay Railway crosses the North-East Dundas Tramway. The deposit was found in the bed of a small creek which flows through the section. The creek had completely filled up the old workings, and I could not examine them, but Mr. G. Beardsley, metallurgist to the Mt. Lyell M. and R. Company, who was interested in the mine at the time the work was done, has kindly furnished me with the following information:—The deposit occurred at the junction of the slate and the decomposed gabbro. On first appearance it gave promise of being a big lode, but afterwards proved to be merely a rock-cavity filled with nickeliferous pyrrhotite. This was connected with a small leader a few inches thick and 12 or 15 feet in length. The water was very heavy, and the leader was not followed down for more than 20 feet. Several parcels of ore were sold, carrying from 8 to 12 per cent. of nickel, 3 to 5 per cent. of copper, an ounce or two of silver, and a trace of gold. The ore was composed principally of nickeliferous pyrrhotite, containing in places small crystals of milerite. This occurrence is evidently of the same type as the nickeliferous pyrrhotite deposits of Sudbury, in Canada, though on an extremely small scale. These deposits are invariably found at or close to the contact of gabbro with the surrounding rocks, and occasionally form short veins in the latter. They are believed to have been produced by a process of differentiation in the gabbro magma during the process of consolidation. J. H. L. Vogt, who has made a special study of these deposits in Canada and Norway, believes that "there is a certain connection or dependence between the size of the gabbro intrusion and that of the ore-mass within it. At all events, very small eruptive districts are characterised only by small segregations."* The dimensions of the gabbro intrusions at North Dundas are very small in comparison with the enormous masses which occur in Canada and Norway, and this may account to some extent for the small dimensions of the ore-deposits. North of the Pieman River, however, very much larger masses of gabbro are known, and it would be well worth while for prospectors in that district to be on the look-out for large deposits of pyrrhotite at the contact of

* J. W. L. Vogt. The formation of eruptive ore deposits. The Mineral Industry, Vol. IV., 1895.

the gabbro and the sedimentary rocks. The nickel contents of the ore which was won at North Dundas is much greater than that of the smelting ore at the best Canadian mines, which only averages from 2.5 to 3 per cent.

The other deposit which I have referred to is situated on the old King Curtin Mine, about three-quarters of a mile north of Ringville. The formation was cut in an old tunnel which was put in from the side of the track between Ringville and the Colebrook Mine. I have only examined the ore at the mouth of the tunnel. It consists of veins and bunches of iron pyrites in quartzite, with small needles of millerite through it. The quartzite also contains small needles of millerite in the joints. Just beyond the tunnel the track passes through a small patch of serpentinised gabbro, so that it is evident that this deposit is also at or close to the contact of this rock. I am not at all sure that this deposit belongs to the same type as the last, but I think it is probable. The millerite in the joints of the quartzite is evidently of secondary origin, and indeed the whole deposit may have been altered considerably by the action of underground waters since it was formed as a segregation from the gabbro.

Appended to this report will be found a table showing the nature, occurrence, and mineralogical composition of the ore deposits of North Dundas. The deposits of nickeliferous pyrrhotite have been omitted, as an exhaustive examination of these deposits was impossible.

In conclusion I desire to thank the numerous mining managers and others in the district for the great assistance they have rendered me during my visit. I am also indebted to Mr. W. H. Baker, B.A., B.Sc., University Lecturer on Chemistry at the Technical School, Launceston, and Mr. H. T. Waller, F.C.S., Director of the Zeehan School of Mines, for much assistance in connection with the theoretical portion of this paper, and especially with regard to the chemistry of the process of the secondary enrichment of the zinc-lead sulphide bodies.

I have the honour to be,

Sir,

Your obedient Servant,

GEORGE A. WALLER,

Assistant Government Geologist.

To W. H. WALLACE, *Esq.*,
Secretary for Mines, Hobart.

JOHN VAIL,

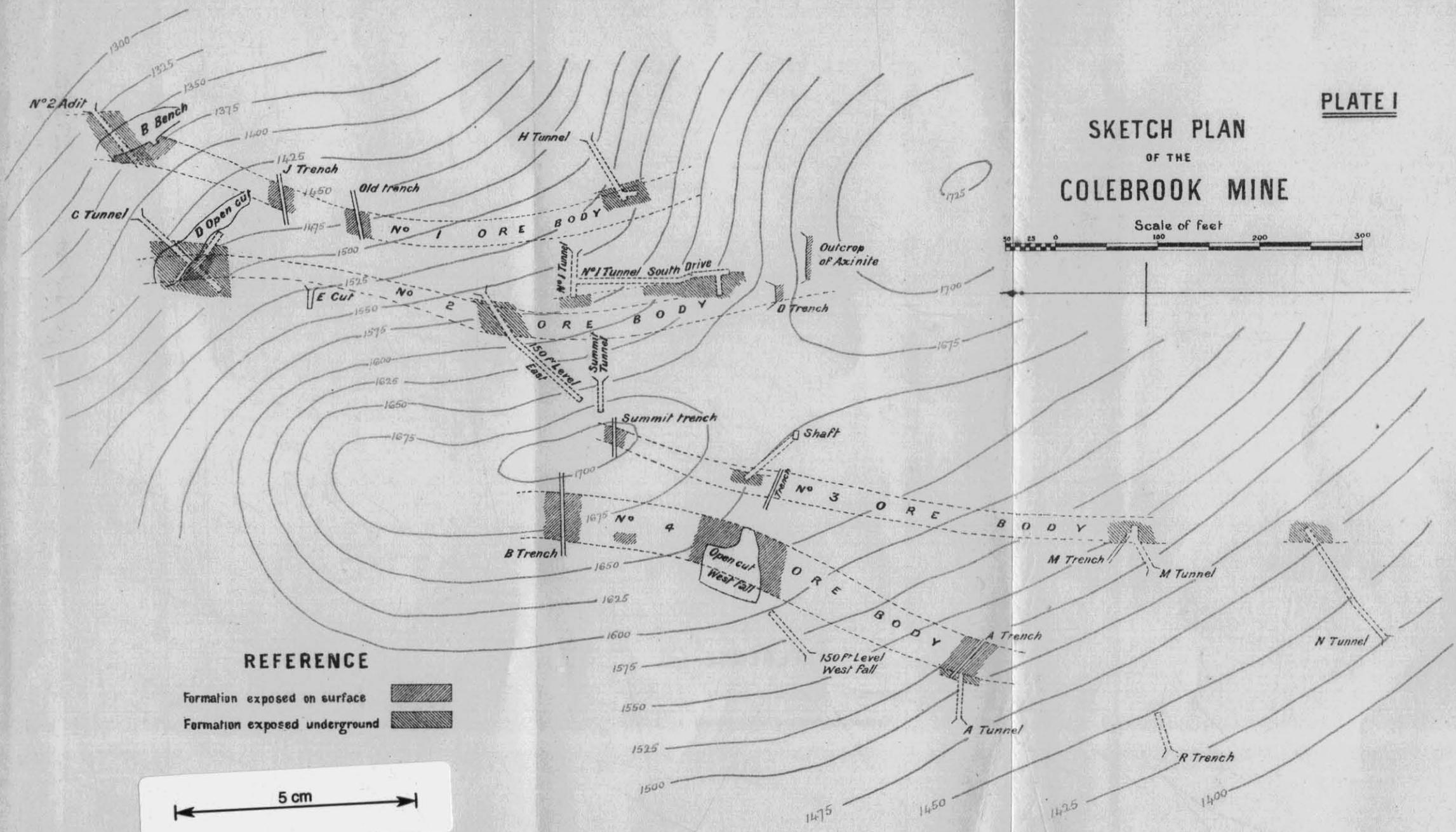
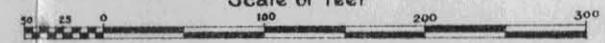
GOVERNMENT PRINTER, TASMANIA.

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PLATE I

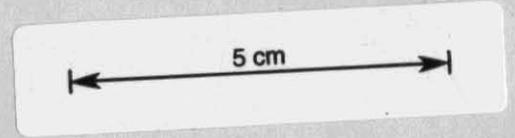
SKETCH PLAN
OF THE
COLEBROOK MINE

Scale of feet

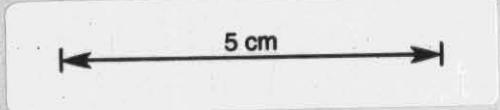


REFERENCE

- Formation exposed on surface
- Formation exposed underground



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SKETCH PLAN OF THE HERCULES MINE

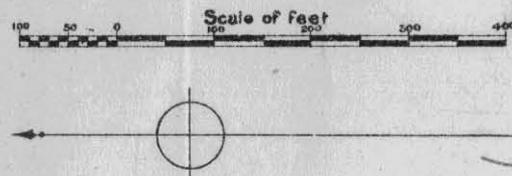
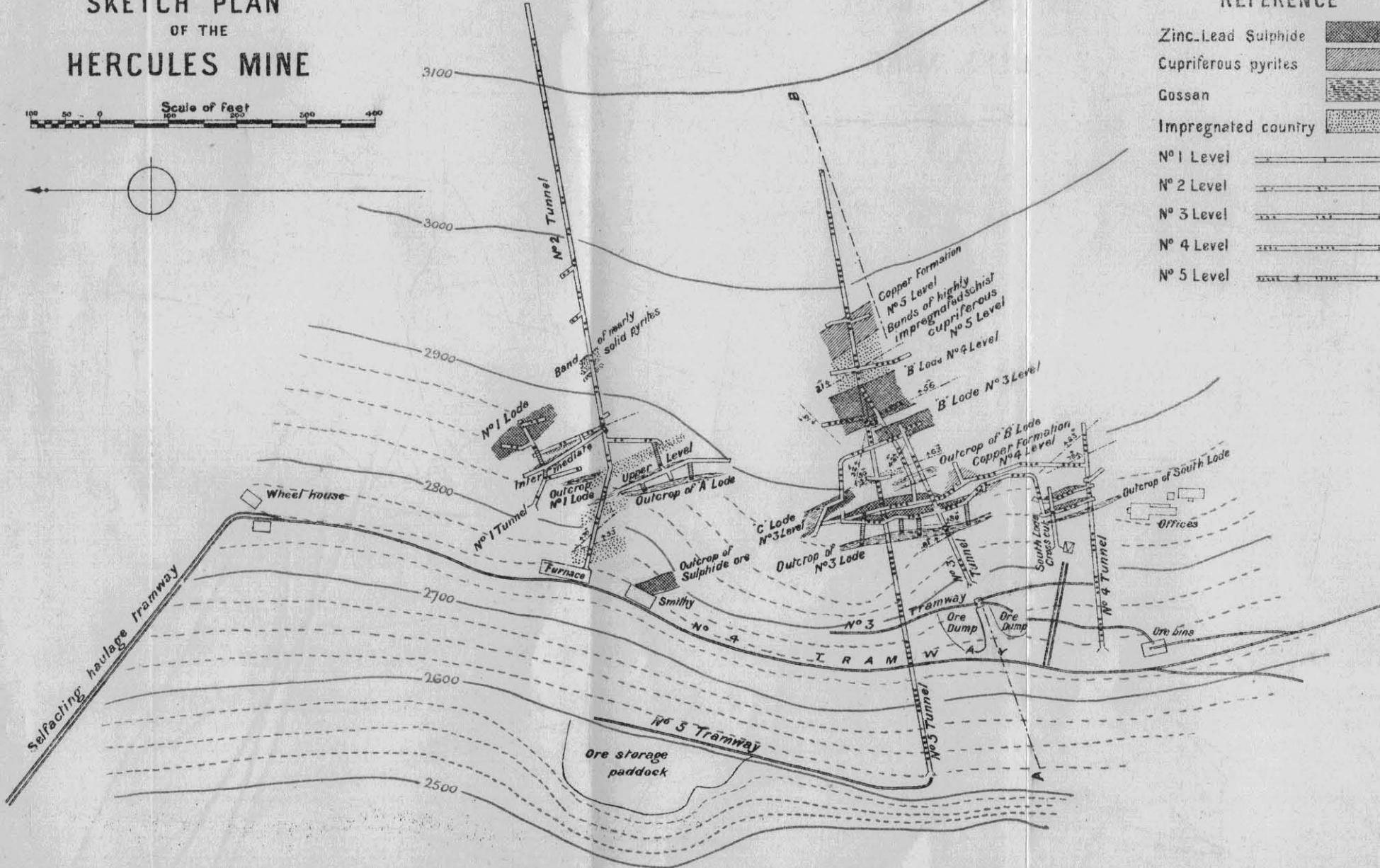


PLATE II

REFERENCE

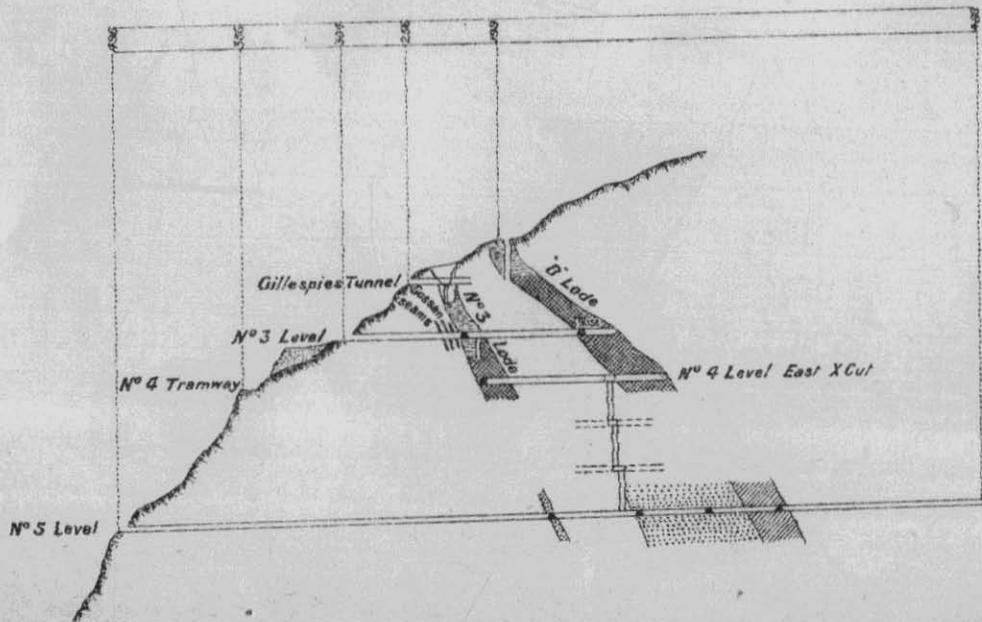
- Zinc-Lead Sulphide
- Cupriferous pyrites
- Gossan
- Impregnated country
- N° 1 Level
- N° 2 Level
- N° 3 Level
- N° 4 Level
- N° 5 Level



HERCULES MINE

PLATE III

Cross Section A_B



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